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VOL. CXXXIV.—No. 3482] LONDON: FRIDAY EVENING, SEPTEMBER 22, 1922 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The University of Sheffield.

SESSION 1922-23.

Vice-Chancellor: Sir HENRY HADOW, C.B.E., M.A., D.Mus.

DEPARTMENTS of MECHANICAL, ELECTRICAL and CIVIL ENGINEERING, METALLURGY, MINING, FUEL TECHNOLOGY and GLASS TECHNOLOGY.

PROFESSORS.

Mechanical Engineering.—W. RIPPER, C.B., D.Eng., D.Sc., M. Inst. C.E.
Metallurgy.—C. H. DESCH, D.Sc., Ph.D., F.I.C.
Civil Engineering.—J. HUSBAND, F.R.C.Sc.I., M.Eng., Assoc. M. Inst. C.E.
Mining.—D. HAY, B.Sc., Assoc. M. Inst. C.E.
Fuel Technology.—R. V. WHEELER, D.Sc., F.I.C.
Glass Technology.—W. E. S. TURNER, O.B.E., D.Sc., F. Inst. P.
Chemistry.—W. P. WYNNE, D.Sc., F.R.S., F.I.C.
Physics.—S. R. MILNER, D.Sc., F.R.S., F. Inst. P.
Geology.—W. G. FEARNSIDES, M.A.
Electrical Engineering.—E. H. CRAPPER, M. Eng., M.I.E.E. (Lecturer).
Mathematics.—C. A. STEWART, M.A. (Lecturer).

The Courses in the DEPARTMENT of ENGINEERING extend over three or four years and prepare students to become Mechanical, Electrical, Civil, or Mining Engineers, or specialists in Fuel Technology, or Glass Technology.

The Courses in the DEPARTMENT of METALLURGY cover a period of three or four years and prepare students for positions of responsibility either (1) in Iron and Steel Manufacture, or (2) in the Non-ferrous Metallurgical Industries.

The LECTURE COURSES in all the Departments are supplemented by Practical Training in Laboratories and Workshops, which are fully equipped for the purpose of advanced scientific teaching, investigation, and research.

Part-time Courses are arranged for students who desire to take special portions of any of the regular courses.

In Mining Engineering, and in certain of the Courses in Mechanical and Electrical Engineering, and in Glass Technology, arrangements are made to enable students, who come to the University from works or collieries, to take six months' courses of study at the University and six months' practice at the works or colliery each year for a period of four years.

The LECTURE COURSES commence OCTOBER 4th, 1922.

The TECHNICAL LABORATORY COURSES commence SEPTEMBER 26th, 1922.

For further details of the Courses and for particulars of the Degrees, Associateships, Diplomas and Certificates awarded on their successful completion, application should be made to

9097 W. M. GIBBONS, Registrar.

Battersea Polytechnic, London, S.W. 11.

Principal: ROBERT H. PICKARD, D.Sc., F.R.S.

ENGINEERING DEPARTMENT.

EVENING CLASSES suitable for Final B.Sc. (Eng.), A.M.I.C.E., A.M.I.M.E., &c., are held in the following SUBJECTS:—

Strength of Materials with Laboratory Testing.
Theory of Structures and Structural Design.
Theory of Machines and Machine Design.
Heat Engines with Laboratory Testing.
Hydraulics with Laboratory Testing.

Students enrolled from September 19th to 22nd.

DAY TECHNICAL COLLEGE.

FULL-TIME COURSES in Mechanical, Civil and Electrical Engineering for B.Sc. (Eng.) Degree, University of London, or College Diploma COMMENCE SEPTEMBER 25th. Entrance examination commences September 19th. Fee: £18 per session. A higher fee will be charged to students not residing in London.

Full particulars of all classes on application to the PRINCIPAL. 166

Northern Polytechnic Institute, HOLLOWAY, LONDON, N. 7.

DEPARTMENT OF ARCHITECTURE. SURVEYING AND BUILDING.

LECTURER in STRUCTURAL STEEL WORK and FERRO-CONCRETE REQUIRED for Fridays, 1.30-4.30. Fee £2s. per period.

Applications for full particulars to be addressed to the SECRETARY at once. 289

ENGINEERING AND TECHNICAL OPTICS.

Northampton Polytechnic Institute.

ST. JOHN-STREET, LONDON, E.C. 1.

ENGINEERING DAY COLLEGE.

FULL-TIME DAY COURSES in the Theory and Practice of Civil, Mechanical and Electrical Engineering. The Courses in Civil and Mechanical Engineering include specialisation in Automobile and AERONAUTICAL Engineering, and those in Electrical Engineering include specialisation in RADIO-TELEGRAPHY.

A SPECIAL ENTRANCE EXAMINATION is held at the end of September before the commencement of each session. The Courses include periods spent in commercial workshops and extend over four years. They also prepare for the Degree of B.Sc. in Engineering at the University of London. Fees, £18 or £13 per annum.

THREE ENTRANCE SCHOLARSHIPS of the value of £62 each for the complete course will be offered for competition at the annual entrance examination in September.

OPTICAL ENGINEERING AND TECHNICAL OPTICS.

Full and Part-time Courses in this important department of Applied Science are given in specially equipped laboratories and lecture rooms. The annual entrance examination is held at the end of September.

EVENING TECHNICAL COURSES

in all branches of Mechanical and Electrical Engineering commence on Monday, September 25th, 1922.

The Laboratories, both Mechanical and Electrical, are well equipped with modern apparatus, which, on the Mechanical side, provides for specialisation in Automobile and Aeronautical Engineering, and, on the Electrical side, for specialisation in Alternate and Continuous-current Work, in Radio-Telegraphy and Telephony, and in Electrical Testing.

More complete particulars, together with conditions of entrance, &c., and all information respecting the work of the Institute can be obtained at the Institute or on application to

192 R. MULLINEUX WALMSLEY, D.Sc., Principal.

The Engineer

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Electrolytic Zinc Works in Tasmania.

British Association at Hull—No. II.

The Gennevilliers Electric Power Station (With a Two-Page Supplement).

Scientific and Industrial Research.

Mining Enterprise in China.

Institute of Metals at Swansea—No. I.

A Large Armour Plate Grinding Machine.

An Electric Submerged Log.

PUBLIC NOTICES

Technical College, Bradford.

DAY COURSES.

FULL-TIME (Day) COURSES, extending over three or four years, and leading to the Diploma of the College, are arranged in the following Departments:—

TEXTILE INDUSTRIES.
CHEMISTRY.
DYEING.
MECHANICAL ENGINEERING.
CIVIL ENGINEERING.
ELECTRICAL ENGINEERING.
BIOLOGY.

Special facilities are available for ADVANCED STUDY and RESEARCH.

Further particulars and prospectuses may be obtained on application to the PRINCIPAL, Technical College, Bradford. 283

G. R.

BY DIRECTION OF THE DISPOSAL BOARD.

For Sale by Tender,

ELECTRICAL POWER STATION

GENERATING PLANT,

At H.M. FACTORY, GRETNA.

OFFERS are INVITED for PART of the ELECTRICAL POWER STATION GENERATING PLANT at H.M. Factory, Gretna.

The Plant that is available consists of:—

TWO 3000 K.W. (4000 K.V.A.) ALTERNATORS, 3000 r.p.m., 50 cycles, 3-phase, and direct-coupled EXCITERS, each coupled to a High-pressure Curtis TURBINE arranged for 185 lb. per sq. in. working pressure, 500 deg. F. total temperature, and exhausting to 28in. vacuum, complete with Steel Separators, Steam Traps, Oil Coolers, Stop Valves, Steam and Vacuum Gauges, &c.

Makers, British Thomson-Houston.
Maker's Nos.: Turbines, 588, 647.
Alternators, 17,658, 19,258.

Each set is complete with a surface condenser having an area of 6300 sq. ft. and capable of dealing with 40,000 lb. of steam per hour; a three-throw Edwards air pump, and an 18in. centrifugal circulating pump, each driven by an electric motor on a 440 v., 3-ph., 50-cycle circuit.

Makers, Cole, Marchent and Morley.

TWO Heenan and Froude 82in. Wet Air FILTERS, complete with Air Trunking Inlet to Generators; 4 H.P. Motors and Two Small Water Inlets fitted with Ball Taps.

FOUR Babcock and Wilcox BOILERS, each with a heating surface of 5356 sq. ft., and fitted with Mechanical Chain-grate Stokers and Internal Superheaters having an area of 1320 sq. ft., capable of superheating to 540 deg. F.

The boilers are complete with all fittings and a 200-tube Green's Economiser is fitted with each boiler, and a motor-driven Induced Fan is fitted with each pair.

Permits to view, Tender forms, and conditions of sale can be obtained on application from the CONTROLLER, D.B.I.E., Plant and Machinery Section, Block "C," Earl's Court Exhibition, London, S.W. 5. 313

TO COLLIERIES, ENGINEERS, BOROUGH ENGINEERS, CONTRACTORS, AND OTHERS.

BURNT RED ASHES.

Large Supplies of Burnt Red

ASHES WANTED, from Refuse Destructors, Pits, Collieries, Furnaces, Factories, &c. &c.

Shale is of NO use.

Write, giving particulars of supply and send 1 lb. sample (not more), to Box 5129, C. D. Flint, Ltd., 76A, Chancery-lane, London, W.C. 2. 222

PUBLIC NOTICES

Aberdeen Corporation Water-Works.

EXTENSIONS 1920.

CONTRACT No. 7.—NEW AQUEDUCT.

The Town Council of Aberdeen are prepared to receive TENDERS from competent persons willing to enter into a contract for the TRANSPORTING, LAYING and JOINTING of 2 MILES of 48in. MILD STEEL PIPING and ANCILLARY WORKS between Gateside of Inchmarlo and Banchory Railway Station.

The drawings may be inspected and specifications, schedule of quantities and forms of Tender obtained on and after 21st September, 1922, on application at the Water Engineer's Office, 41½, Union-street, Aberdeen.

For each specification a deposit of Five Pounds Sterling in cash will be required, which sum will, after a Tender has been accepted, be returned to the tenderer, provided that he shall have sent in a bona fide Tender, based on the drawings, specification, and schedule of quantities provided with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.

Tenders on the forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for New Aqueduct," and addressed to the undersigned, must be delivered not later than 11th October, 1922.

The Town Council do not bind themselves to accept the lowest or any Tender.

GEORGE MITCHELL, M. Inst. C.E., Water Engineer.

Water Engineer's Office,
41½, Union-street, Aberdeen,
12th September, 1922. 252

Auckland Harbour Board, New Zealand.

TENDERS are INVITED for the SUPPLY and DELIVERY of:—

TWELVE (12) 5-Ton (and alternatively for 3-Ton) Semi-portal Balanced Jib ELECTRIC QUAY CRANES.

FOUR (4) 5-Ton (and alternatively for 3-Ton) Balanced Jib ELECTRIC ROOF CRANES.

SIX (6) 1-Ton ELECTRIC MONO-RAIL CRANES.

Specifications, diagrams and forms of Tender can be obtained at the office of the Board's Agents,

Messrs. W. and A. McArthur, Ltd.,
16/19, Silk-street,
Cripplegate, London, E.C. 2,

on payment of a deposit (returnable) of Two Guineas.

Tenders to reach Auckland by Noon on February 1st, 1923, addressed "The CHAIRMAN, Harbour Board, Auckland, New Zealand." 9008

Tyne Improvement Commission.

DREDGING PLANT.

The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION and DELIVERY in the Tyne of the undermentioned:—

ONE NON-PROPELLED CENTRE LADDER BARGE LOADING BUCKET DREDGER.
FOUR SINGLE-SCREW STEEL STEAM HOPPER BARGES, each with a hopper capacity of 800 tons.

Copies of the form of Tender, conditions of contract, general specification and outline drawings may be obtained from this office on payment of a deposit of Five Guineas for the specifications, &c., of the dredger and the hopper barges respectively. The deposit will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Dredging Plant," must be delivered at the undermentioned offices, addressed "The Chairman, Dredging and River Works Committee," not later than Noon on Saturday, the 28th of October, 1922.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
J. McDONALD MANSON,
General Manager and Secretary.

Tyne Improvement Commission Offices,
Bewick-street,
Newcastle-upon-Tyne,
September 20th, 1922. 319

PUBLIC NOTICES

APPLICATION FOR A LICENCE OF THE BOARD OF TRADE.

Notice is Hereby Given that,

in pursuance of the 20th Section of the Companies (Consolidation) Act, 1908, APPLICATION has been made to the Board of Trade for a LICENCE directing an Association about to be formed under the name of "THE INSTITUTION OF ENGINEERING INSPECTION" to be registered with limited liability without the addition of the word "limited" to its name.

The objects for which the Association is proposed to be established are:—

To take over such of the assets and liabilities, if any, of an un-incorporated Association known as "The Technical Inspection Association" as may lawfully be taken over by the Institution.

The other objects of the Association are set out in extenso in the Memorandum of Association, a copy of which may be inspected at the office of Ernest A. Kite, Esq., 2, Dean's-yard, The Sanctuary, Westminster, S.W. 1, Solicitor.

NOTICE is HEREBY FURTHER GIVEN that any Person, Company, or Corporation objecting to this application may bring such objection before the Board of Trade on or before the 16th day of October next by a letter addressed to the Comptroller of the Companies Department, Board of Trade, Great George-street, London, S.W. 1.

Dated this 20th day of September, 1922.

C. J. WHARTON,
318 Hon. Secretary.

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for the following:—

700 STEEL TYRES.

Specification and form of Tender can be obtained at the Company's Offices, 122, Gresham House, Old Broad-street, London, E.C. 2, on or after 20th September, 1922.

A fee of £1 1s. will be charged for the specification, which will not be returned.

Tenders must be submitted not later than Noon on Monday, 2nd October, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
T. R. WYNNE,
287 Managing Director.

Croydon Union.

TO LAUNDRY ENGINEERS, &c.

The Guardians of the above-named Union invite QUOTATIONS for the following LAUNDRY MACHINERY required at their Infirmary, viz.:—

(a) ONE ROTARY FOUL WASHING MACHINE of 125 Adult Shirt Capacity.
(b) ONE 22in. HYDRO, and (c) ONE ROTARY WASHING MACHINE of 80 Adult Shirt Capacity.

Inspection of the laundry by persons desiring to Tender may be arranged with the Steward of the Infirmary.

Forms of specification and other particulars may be obtained of the undersigned and must be returned not later than Monday, October 2nd, 1922.

NORMAN P. WALKER,
Clerk to the Guardians.

Union Offices,
Mayday-road,
Thornton Heath, Surrey.
19th September, 1922. 317

Bombay, Baroda, and Central India Railway Company.

The Directors are prepared to receive up to Noon on Friday, 6th October, TENDERS for the SUPPLY of:—

1. STEEL MATERIAL.
2. WHEELS AND AXLES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France, Westminster, S.W. 1,
20th September, 1922. 314

City of Liverpool.

TO ENGINEERING CONTRACTORS.

The Corporation invite TENDERS for ONE CORNISH BOILER, 19ft. by 6ft., to be installed at Lodge-lane Baths and Washhouse.

Specification may be obtained on application to the Engineer and Chief Superintendent, Baths Department, 75, Dale-street, Liverpool, on payment of 10s., which will be returned on receipt of a bona fide Tender.

Tenders must be enclosed and sealed up in an envelope, addressed to the Town Clerk, Municipal Buildings, Liverpool, endorsed "Tender for Boiler, Baths Department," and delivered by letter post not later than Twelve Noon on Tuesday, the 10th October, 1922.

The Corporation do not bind themselves to accept the lowest or any Tender.

G. HAMMOND ETHERTON,
Town Clerk.
Liverpool, 16th September, 1922. 290

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PUBLIC NOTICES

State Electricity Commission
OF VICTORIA.
TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification will be available on and after 21st September, 1922, upon application to

Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 308.—BACK-PRESSURE STEAM TURBINE, including ONE 1600 KW. TURBO-ALTERNATOR with EXHAUST VALVES, EXHAUST PRESSURE REGULATOR, CONTROLLING STEAM ADMISSION, BY-PASS REDUCING VALVES, &c.; steam 250 lb. per square inch. 650° Fah., exhaust 15 lb. to 45 lb. gauge; Alternator 6600 volts, 3-phase, 50 cycles.

SPECIFICATION No. 317.—WATER-TUBE BOILERS and ACCESSORIES, including:—
SECTION 1.—FOUR BOILERS, 4500 sq. ft. H.S., STEP GRATES, DAMPERS, MOUNTINGS, &c.
SECTION 2.—STRUCTURAL STEEL WORK for BOILER-HOUSE, BUNKERS and TURBINE HOUSE, including FLOOR FRAMING, STAIRS, &c.
SECTION 3.—TURBINE-DRIVEN FEED PUMPS, MAKE-UP PUMPS, COLLECTOR DRUMS, TANKS, METERS, &c.
SECTION 4.—COMPLETE SYSTEM of PIPING, VALVES, &c., for all PLANT.

Both the above specifications cover the supply, delivery, and supervision of erection of complete plant, sections being inseparable.

CHARGE.—£3 3s. for the first two copies of Tender form, conditions of contract, and specification complete. These charges will be returned on receipt of a bona fide Tender. A third copy and any further copies will be supplied for the sum of £1 1s. each.

PRELIMINARY DEPOSIT.—A preliminary deposit of £50 is to be lodged with Tender in each instance.

The specifications may be inspected at the above-mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on the prescribed forms, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m. on the date of Specification No. 308, 31st January, 1923, and in the case of Specification 317, 15th January, 1923.

R. LIDDELOW, Secretary,
State Electricity Commission of Victoria,
304 Melbourne, Victoria, Australia.

The Metropolitan Borough of
HACKNEY.
GARAGE.

The Borough Council are prepared to receive DESIGNS accompanied by TENDERS, for the CONSTRUCTION of a GARAGE in Reinforced Concrete, to accommodate 28 electric vehicles, together with ENCLOSURES for WORKSHOP, OFFICE, STORES, MOTOR GENERATORS, &c., at Millfields-road, Clapton, E. 5.

Site plan and drawing showing a suggested general arrangement of the proposed building and full particulars of the scheme may be obtained on application to Mr. Morgan Seorgie, M. Inst. C.E., Borough Engineer and Surveyor, upon payment of One Guinea, which will be returned (after the Designs and Tenders have been considered and determined upon by the Council) subject to the receipt by the Council of a bona fide Design and Tender, duly delivered in the manner described hereunder and not withdrawn.

Tenders must be placed in an envelope, sealed with sealing wax and endorsed "Tender for Garage at Millfields-road," accompanied by the Design and full particulars, and must be delivered by the person or firm tendering or by an authorised representative to the Chairman at a meeting of the Establishment and General Purposes Committee of the Council, to be held at 7.30 p.m. on Monday, October 2nd, 1922, at the Town Hall, Mare-street, Hackney, E. 8, or otherwise be sent by post by registered letter, addressed to the Chairman of the Committee, so as to be delivered to him not later than the time named above.

Designs and Tenders delivered or sent otherwise will not be accepted.

The Council does not bind itself to accept any Design or the lowest or any Tender.

R. H. R. TEE,
Town Clerk.

Town Hall,
Mare-street, E. 8,
September 18th, 1922. 288

The South Indian Railway Com-
PANY, Limited, are prepared to receive TENDERS for the SUPPLY of:—
1. BRUSHES.
2. LAMINATED, HELICAL and VOLUTE SPRINGS.
3. FOUNDRY COKE.
4. CARRIAGE FITTINGS.

Specifications and forms of Tender will be available on Monday, the 25th September, 1922, at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Brushes," or as the case may be, must be left with the undersigned not later than Twelve Noon on Tuesday, the 10th October, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of the specifications.

Copies of the drawings may be obtained at the office of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, S.W. 1,
22nd September, 1922. 315

London and North-Western
RAILWAY COMPANY.
GENERATING PLANT FOR SALE.

The Railway Company INVITE OFFERS for the following:—
ONE "Yates and Thom" CROSS COMPOUND CORLISS HORIZONTAL ENGINE, direct coupled to a 1560 K.W. "Dick-Kerr" GENERATOR.

The set is suitable for a steam pressure of 160 lb. per sq. in. and generates A.C., 3-phase, 7500 volts, 25 cycles current when running at 75 revs. per min. High-pressure cylinders 32in. dia. by 4ft. 6in. stroke, and low-pressure cylinders 64in. dia. by 4ft. 6in. stroke, and indicated horse-power 2310.

The set is fitted in the centre of the crank shaft with a large fly-wheel alternator, so that it is possible for the engine to be converted for rope driving.

The set, which is complete with jet condensing plant, air pump, and spare parts, &c., is at present in working condition and may be seen running during the next few weeks at Formby Power Station, on the Liverpool and Southport line. The total weight of this set is in the neighbourhood of 295 tons.

This set can be inspected on site, and any further information can be obtained on applications to GEO. RUGHES, Chief Mechanical and Electrical Engineer, L. and N.W. Railway Works, Horwich, S.O. Lancashire. 268

SITUATIONS OPEN

WANTED by Engineering Firm in India, JUNIOR ACCOUNTANT, age about 25, and single, with experience in engineering firms in thiscountry.—Reply, with full details of experience, stating age and salary required, Z. E. 645, care Deacon's, Leadenhall-street, E.C. 3. 301 A

WANTED for the East, by an Old-established British house, a young and energetic MAN, with a thorough practical knowledge of the Manufacture of all classes of Hollow-ware. Must be capable of doing his own drawings and supervisethe making of tools. One with a knowledge of Drop Stamping will be preferred. Applicants must state full particulars of their record and training. Good salary and excellent prospects to the right man.—Write, A. Z., c/o Crosley and Co., Ltd., 5, Racquet-court, Fleet-street, E.C. 4. 297 A

NEW 8'4"
VERTICAL BORING & TURNING MILL
Single Pulley Drive. Latest Design.
FOR IMMEDIATE DELIVERY.
Weight: 30 TONS.

MARTIN BROS. (MACHINERY), LTD.,
35, BRIDGE STREET,
MANCHESTER.
307 G

SITUATIONS OPEN (continued)

WANTED, ENGINEER, to Take Charge of Oil Engine Dept. of large Firm of General Engineers; first-class technical man with experience in latest design of Diesel and Semi-Diesel Engines essential; must be competent to negotiate sales and have good connection with purchasers in this market.—Address, stating age, full particulars of experience, and salary expected, 283, The Engineer Office. 283 A

WANTED, WORKING ENGINEER with Sea Experience, able efficiently and economically to keep in good running order six marine internal combustion engines installed in small coasting vessels.—Address, with full particulars of experience and wages required, P6112, The Engineer Office. P6112 A

WANTED for Production Department, ENGINEER who has had wide experience. Must be capable of making date programmes for drawing-office information, material supplies and shop manufacture, and have the capacity for seeing that these dates are kept to meet contract obligations. It is requested that only men who have held responsible executive positions will reply. State experience, salary, age, &c.—Address, 239, The Engineer Office. 239 A

AN Important MOTOR CAR CO. REQUIRES the SERVICES of an experienced MACHINE SHOP SUPERINTENDENT to control all departments. All applicants to state experience in full, age, and approximate salary required.—Address, 323, The Engineer Office. 323 A

CONTRACTOR'S AGENT-ENGINEER WANTED by a leading Firm of Westminster Civil Engineering Contractors. Must be thoroughly experienced in all branches of work, including preparation of tenders.—Address, giving age, experience, and salary required, 321, The Engineer Office. 321 A

ENGINEER SALESMAN WANTED for Birmingham district, to Represent Large Firm manufacturing products for General Engineering and Automobile Trade. Applicant must be sound technical man, with selling experience, and have good connections in the district.—Address, stating age, salary required, &c., and full particulars of experience and training, P6095, The Engineer Office. P6095 A

LIFTS.—LIVE REPRESENTATIVE WANTED by leading Electric Lift Manufacturers in London. State full particulars and salary required.—Address, P6110, The Engineer Office. P6110 A

REQUIRED by Old-established Engineering Company in India, thoroughly trained and educated TECHNICAL ENGINEER, age 22-25, single, with commercial sales experience in W.I. Tubes and Engineers' Stores.—Reply, fully stating age and salary expected, Z. X. 638, care Deacon's, Leadenhall-street, London. 300 A

SECRETARY WANTED for Engineering Firm (Motor Cycles) in Yorkshire. Position does not call for a deep knowledge of secretarial practice, but does need a man with energy, initiative, and good organising ability. Moderate commencing salary, but excellent prospects. Write, giving details of past experience, references, and salary required.—Address, 332, The Engineer Office. 332 A

TEA PLANTING.—An Important TEA COMPANY has a VACANCY on its European Staff for a YOUNG GENTLEMAN (age 22-24 and unmarried) with engineering experience to become a Tea Planter on its gardens in Assam. The position would be under a three years' agreement, commencing from the date of arrival at the gardens, and salary for the first year would be at the rate of Rs. 225 a month, rising by annual increments of Rs. 25 a month to Rs. 275 a month in the third year. Passage to the gardens would be paid by the company.—Applications should be addressed to Box "ASSAM," c/o Davies and Co., 95, Bishopsgate, London, E.C. 2, and should contain full particulars as to age, education, and engineering experience. 298 A

TECHNICAL ASSISTANT WANTED by London Engineering Firm, to deal with correspondence. Commercial experience necessary. Moderate salary to commence with. Write, stating experience, age, and salary required.—Address, 325, The Engineer Office. 325 A

WANTED, DRAUGHTSMAN, Experienced in Breaking and Crushing Plant, Elevators, Conveyors, and Tar-macadam Plant. Applications treated in confidence.—JOHN F. WAKE, Darlington. 293 A

DRAUGHTSMAN REQUIRED AT ONCE for Steel Works Plant. Must have knowledge of Structural and Mechanical Engineering, Surveying, &c. No others need apply. State age, salary, experience, and when at liberty.—Address, 310, The Engineer Office. 310 A

DRAUGHTSMAN (Senior) REQUIRED for Large Engineering Establishment, with wide experience in A.C. and D.C. Motors. Only efficient men should apply, giving particulars of experience, age, and salary required.—Address, 266, The Engineer Office. 266 A

DRAUGHTSMAN WANTED. Must be Capable of Designing Complete Coal Screening Plants.—Address, stating age, experience, and salary required, 232, The Engineer Office. 232 A

RAILWAY CARRIAGE and WAGON DRAUGHTSMAN (first class) REQUIRED for North Midland district, to supervise juniors, check drawings, and requisition materials. State age, salary required, and experience.—Address, 246, The Engineer Office. 246 A

SITUATIONS WANTED

WANTED, a JOB for a MECHANICAL ENGINEER. G.I. Mech. E. (25), 8 years' exp., technical, shops, and D.O.—Address, P6099, The Engineer Office. P6099 B

ABROAD, U.S.A. Preferred. Trained ENGINEER DESIRES POSITION; 10 years' general experience, Home and abroad; practical, technical, commercial; good knowledge Spanish and French.—Address, P6117, The Engineer Office. P6117 B

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For continuation of Small Advertisements see page 3.

Electrolytic Zinc Works in Tasmania.

THE establishment within the British Empire of the largest zinc-producing plant in the world is an event of outstanding importance, and while the national and international significance of the great undertaking in Tasmania transcends the purely engineering features of the scheme, there are no departments of engineering which have not been engaged in the development of the works, which we illustrate on page 300.

The Electrolytic Zinc Company of Australasia, Limited, did not proceed with the construction of so large a plant without exhaustive preparatory examination of methods for the production of zinc by electrolysis, and in applying such methods to the complex ores of Broken Hill and Tasmania, much electro-chemical and metallurgical research work had to be undertaken, notwithstanding the advanced knowledge of the technique of zinc refining which was already at the disposal of the Australian producers of raw concentrates and spelter. The original experiments were conducted with a glass cell having a capacity of 6 lb. of zinc per twenty-four hours. This tiny experimental station was followed, very shortly, by a unit capable of producing 600 lb. of zinc per twenty-four hours, the results then observed being such as to warrant the establishment of a plant producing 30,000 lb. of zinc per twenty-four hours.

This 30,000 lb. plant received energy from the hydro-electric undertaking of the Government of Tasmania, the extra high-tension supply, stepped down to 11,000 volts, being connected to three 1250-kilowatt synchronous motor generator sets built, together with the switchgear, by the British Thomson-Houston Company, Limited. This machinery was contracted for, manufactured, and shipped during the most sombre period of the war; but in spite of the remote nature of the site, and the extreme danger then attending navigation, the plant was delivered and erected at Risdon without the loss of any essential element, and within a week or two of the date scheduled. The success of the 30,000 lb. equipment has led to the construction of the plant shown in the illustrations on page 300, the completed capacity of which is to be 300,000 lb. of refined zinc per day. These illustrations give an excellent general idea of the works, two of them having been reproduced from photographs made from aeroplanes. The wharf marked A provides berths for two ships, while Babcock and Wilcox luffing jib electric cranes, each capable of handling inwards or outwards 100 tons hourly, are in operation on it. A 24in. belt conveyor system, marked B, will carry 250 tons hourly of concentrates or calcines from ship's side into the calcine storage, marked C, which has a capacity of 20,000 tons. An electric shovel, with a capacity of 60 tons hourly, delivers from C into trucks, which are hauled by a high-speed electric winch, housed in the building marked D, up No. 1 haulage, marked E E E, and thence to the final roasters marked F, where the calcine is prepared, and then delivered by a belt conveyor system which has been erected since the photographs were taken between the points G G, to the leach plant, marked H, the necessary intermediate storages being provided throughout the plant.

In the leaching plant the oxide of zinc is extracted from the calcines by sulphuric acid; the insoluble portion enriched in lead and silver, by the removal of the oxide of zinc, is filtered off, dried and prepared for further treatment for the recovery mainly of the lead and silver. The solution of sulphate of zinc, after purification for removal of traces of other metals, is circulated through electrolytic cells in the building marked I, where the electric current, passing from the anodes to the cathodes, deposits zinc on the cathodes and regenerates the sulphuric acid at the anodes. At intervals, the cathodes are lifted mechanically from the cells, and the zinc, which has been deposited as sheets, is removed for transference to the melting house marked J. In the melting house the zinc is cast into 50 lb. slabs and carried by means of a chain conveyor to the wharf for delivery to steamers as required.

The three-phase electrical energy is delivered to the company's power house K from the step-down station of the hydro-electric department of the Tasmanian Government, marked L on the two lower views on page 300. The administration offices are shown at M, the store and warehouse at N, the experimental station at O, the assay office at P, the mechanical shops at Q, the wood-working and pattern-making shops at R, and the main change-house at S. The residues, from which most of the zinc has already been removed in the leaching plant, are delivered by No. 3 haulage, marked T, to the wharf for shipment to Port Pirie, to be smelted there for the recovery of the lead and the silver. The quantity of lead and silver recoverable annually from the average grade residues produced, will approximate 6000 tons of lead and 1,100,000 oz. of silver.

The electrical energy for the production of the zinc is, as has been said, supplied by the hydro-electric plant of the Tasmanian Government. The power is generated at Waddamana and transmitted, at 88,000 volts, a distance of approximately 65 miles, to the Government step-down station at Risdon, where the voltage is reduced to 11,000 volts. This step-down or sub-station is said to be the largest of its kind in the British Empire.

The main function of the electrical equipment installed at the works is to convert three-phase electrical energy supplied at 11,000 volts 50 cycles to direct current for use in the electrolytic cells. In addition, there are transformers for reducing the pressure to 415 volts for driving various motors around the plant, and for the lighting of the establishment. The following is a description of the plant installed for this purpose:—The electrical energy is supplied and measured at the 11,000-volt bus-bars installed in the Government step-down station. At this point, three maximum demand indicators are installed, each with its separate current and potential transformers. For the purpose of accounts the meters are read at the end of every quarter, and reset to zero. The mean of the three meters is taken, but should the reading of any individual meter vary by more than 3 per cent. from the mean of the readings of the three meters, it is taken out of service and tested and an adjustment made after the error of the meter is determined. One of the meters is the property of the Government, one is the property of the Electrolytic Zinc Company, Limited, and the third is the joint property of the supplier and consumer. The total amount of power contracted to be taken by the zinc works is 30,000 horse-power, but at present only half of that quantity is being taken. It is anticipated that the load will be increased to the full figure in January, 1923.

The connection from the Government step-down station to the converter station is by means of four underground cables, each having three cores 0.4 square inch sectional area, paper insulated, lead covered and steel tape armoured. The four cables, which were manufactured at the Prescot Works of the British Insulated and Helsby Cables, Limited, are laid directly in the ground for their entire length.

The high-tension switchgear is of the remote controlled type, the oil switches, current and potential transformers and bus-bars being mounted in concrete cubicles. The whole of the control is carried out from a bench type switchboard, and the control circuits are supplied from a storage battery at 240 volts. This battery voltage has been selected on account of the fact that the whole of the lighting of the plant is carried out at 240 volts, and in the event of a power failure at night, a change-over switch enables certain essential emergency lights to be switched over from the alternating-current supply to the storage battery. The high-tension cubicle structure carries two complete sets of 11,000-volt bus-bars with two rotary selector (isolating) switches to each circuit. The electrolytic plant operates continuously on full load, twenty-four hours per day, seven days per week, and this arrangement of duplicate bus-bars and selector switches makes it possible for either of the bus-bars to be completely isolated for the purpose of inspection and the cleaning of insulators without the necessity of shutting down any section of the plant. The doors which give access to the oil switch and instrument transformer compartment are so interlocked with the isolating switches that both isolating switches on each circuit must be opened before it is possible to open the cubicle doors, and, on the other hand, when these doors are opened, it is not possible to close the isolating switches.

Seven rotary converters, each rated for a direct current output of 3000 kilowatts, continously with a temperature rise not exceeding 40 deg. Cent., have been installed—see the accompanying engraving. Each converter is connected to three single-phase oil-immersed transformers made by the General Electric Company, of Schenectady, and provided with tappings to enable the voltage impressed on the converter slip rings to be increased by 5 per cent. or decreased by 5 or 10 per cent. All of the transformers are permanently connected to a piping system which leads to an oil-filtering equipment. This latter enables the oil to be drawn off from any transformer and filtered. An oil storage tank is provided from which any transformer, which has been emptied of its oil, can be immediately refilled without having to wait until the oil which is drawn off has been filtered. Each rotary converter is provided with an induction voltage regulator mounted directly on to the bed-plate of the machine. This induction regulator is operated by a small alternating current motor controlled from the main switchboard, but is capable of also being controlled by hand. The induction regulator enables the rotary converter to give a pressure variation on the direct-current side of 500 to 600 volts when connected to the normal tappings of the transformers. The windings of the induction regulator are cooled by air, which is circulated by means of a fan mounted at the alternating-current end of the bed-plate and driven by a belt from a pulley mounted on the rotary converter shaft at the extreme end of the starting motor. The rotary converters are of the self-synchronising type, a starting motor being mounted on the alternating-current end of the machine. The starting panel is mounted on the converter station floor, and the starting operation is as follows:—(*a*) The high-tension is closed from the main switchboard which connects the transformers on to the 11,000-volt bus-bars; (*b*) The oil switch on the starting panel is then closed so as to connect the starting motor in series with the slip rings and the transformers; (*c*) The induction motor starts the converter and brings the armature up to synchronous speed. At this point, the motor acts as a synchronising reactance and allows the converter to synchronise automatically with the supply through the stator windings of the motor.

A volt meter with synchronising lamps is connected across one of the phases of the starting motor, and when this indicates that the converter has synchronised, the induction motor stator windings are short circuited by means of three hand-operated single-pole knife switches, which connect the slip rings direct to the transformers, and the machine is then paralleled on to the direct-current bus-bars. Each machine runs at a speed of 250 revolutions per minute, and is equipped with an over-speed automatic cut-out. An end-play device which maintains an automatic reciprocating motion of the armature, in a direction parallel with the shaft, is also provided. The field rheostat is mounted close to the machine, and is remote controlled from the main switchboard.

As a very heavy current has to be handled from each converter, the direct-current switchgear is mounted on the converter station floor near the commutator end of each machine in order to reduce the length of the copper connections to a minimum. The switchgear is of the remote controlled type, and is operated from the main switchboard. The

INTERIOR OF ROTARY CONVERTER HOUSE

TABLE I.—*Swedish Oil Engine—Results of Tests.*

Load in per cent. of rated load	..	..	..	..	..	..	..	..	133	125	100	118	100	100	75	50	25	30	12.5	137	133	128	118	100	100	75	50	25
Brake load, kilogrammes	..	..	..	..	..	..	..	..	150	139	110	133	110	110	83	55	28	50	28	153	148	143	133	110	110	83	55	28
Number of revolutions during test	..	..	..	..	..	..	..	..	3,466	5,573	9,492	3,921	8,813	5,887	3,743	3,753	3,863	4,131	—	—	—	—	3,921	8,813	5,887	3,743	3,753	3,863
Aspect of the exhaust gases	..	..	..	..	..	..	..	..	Invisible	Invisible	Invisible	Faintly visible	Invisible	Traces	perceivable on background	black	Faint smoke	Invisible	Smoke	Faintly visible	Faintly visible	Faintly visible	Faintly visible	Invisible	Traces	perceivable on background	black	Faint smoke
Temperature of exhaust gases, deg. Cent.	..	..	..	..	..	..	..	..	468	420	339	390	325	325	270	210	150	252	—	470	450	420	390	325	325	270	210	150
,, of discharged cooling water, deg. Cent.	..	..	..	..	..	..	..	..	70.5	70	62	—	62	—	63.5	—	57.5	61.5	—	—	—	—	—	62	—	63.5	—	57.5
,, of engine-room, deg. Cent.	..	..	..	..	..	..	..	..	16	15.5	14	15	13	13	13.5	13.5	13	13	—	—	—	—	15	13	13	13.5	13.5	13
,, at filter, deg. Cent.	..	..	..	..	..	..	..	..	—	—	—	47	45	46	46	46	48	—	—	—	—	—	47	45	46	46	46	48
,, in fuel pump, deg. Cent.	..	..	..	..	..	..	..	..	—	—	—	44	40	42	43	42.5	42	—	—	—	—	—	44	40	42	43	42.5	42
Barometric pressure of atmosphere, mm. Hg.	..	..	..	..	..	..	..	..	762	760	760	767.5	767.5	767.5	767.5	767.5	767.5	762	762	767.5	767.5	767.5	767.5	767.5	767.5	767.5	767.5	767.5
Temperature of air near inlet valves, deg. Cent.	..	..	..	..	..	..	..	..	31.5	31	25.5	—	24	—	27	—	—	—	—	—	—	—	—	24	—	27	—	—
Position of ignition lever, notch number	..	..	..	..	..	..	..	..	24	24	24	24	24	24	23	—	—	25	24	—	—	—	24	24	24	23	—	—
Position of load lever, notch number	..	..	..	..	..	..	..	..	23	23	18	20.5	19.5	19.5	17	15	28	23	23	—	—	—	20.5	19.5	19.5	17	15	28
Revolutions per minute	..	..	..	..	..	..	..	..	21.5	20	18	300	295.9	296.6	295.4	294.8	298.1	16	13	300	300	300	300	295.9	297.7	296.6	295.4	294.8	298.1
Brake horse-power (metric)	..	..	..	..	..	..	..	..	297.0	298.2	297.1	83.7	76.8	63.9	47.9	31.6	16.3	247.8	195.8	89.6	86.7	83.7	76.8	63.9	63.7	47.9	31.6	16.3
Fuel consumption per hour, grammes	..	..	..	..	..	..	..	..	16,607	14,600	11,213	14,839	11,758	12,453	8,619	6,415	4,699	37.2	19.1	8.2	—	—	—	—	—	—	—	—
Fuel consumption per brake horse-power-hour, grammes	..	..	..	..	..	..	..	..	190.9	180.4	175.7	193.7	184	180.3	180.2	202.8	288.6	7,073	4,011	150	300	300	295.9	297.7	296.6	295.4	294.8	298.1
Kind of fuel	..	..	..	..	..	..	..	..	Galisol	Galisol	Galisol	Mexican fuel oil intended for firing						189.8	211.5	Galisol	—	—	—	—	—	—	—	—
Heat units consumed per brake horse-power-hour, calories	..	..	..	..	..	..	..	..	1,926	1,820	1,773	1,938	1,841	1,805	1,804	2,030	2,869	2,134	—	—	—	—	—	—	—	—	—	—
Total thermodynamic efficiency, per cent.	..	..	..	..	..	..	..	..	32.7	34.7	35.6	32.6	34.3	35.0	35.0	31.1	21.9	33.0	29.5	7.40	7.16	6.91	6.43	5.32	5.32	4.02	2.66	1.35	1,915	2.42	1.35	—	—	—	—	—	—	—	—	—	—
Mean effective pressure, kilogrammes per square centimetre	..	..	..	..	..	..	..	..	7.24	6.71	5.31	—	—	—	—	—	—	33.0	29.5	—	—	—	—	—	—	—	—	—
																		3.72	2.42	—	—	—	—	—	—	—	—	—
																		—	—

purities from entering the fuel pump and the fuel valve in solid injection engines. As a measure of further precaution, a similar, although smaller filter is placed in the body of the fuel valve. This filter is of considerable value as long as the pipes are new and scale and other mechanical impurities from the inside of the pipes and the joints may be carried along by the fuel.

The fuel valve is shown in section in Fig. 3. The

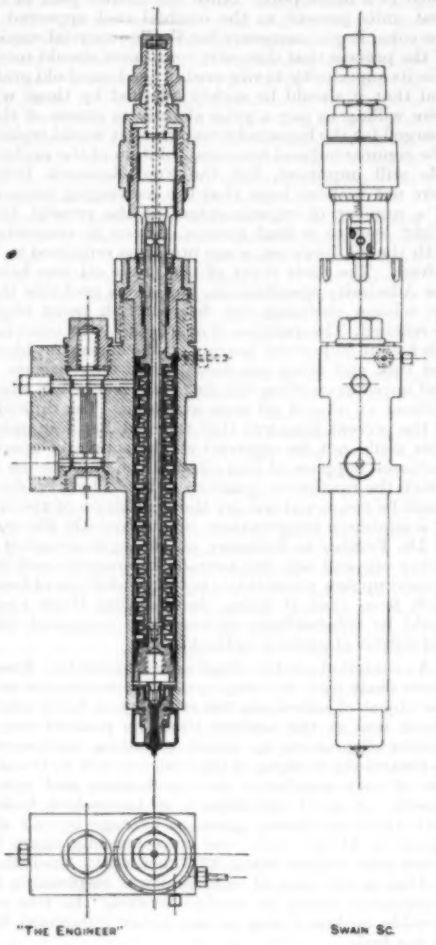


FIG. 3—FUEL VALVE

spring is of particular interest. It is composed of elastic spring elements, shown in Fig. 6, which may be described as consisting of two annular discs connected by a short hollow cylinder. The elastic properties of these discs have been the object of thorough theoretical investigations by Professor K. Ljungberg, Stockholm, Sweden, an abstract of whose views has been published in *Teknisk Tidskrift, Mekanik*, 1920, No. 4. Adjoining elements are connected to each other by shrink rings and separated from each other by distance rings. In this manner it is possible to construct a very stiff spring of smaller dimensions, for the force exerted, than can be attained in any other way. To show how firmly under practical conditions the spring elements are held together by the shrink rings, it may be stated that more than 550 lb. were required to pull apart the elements which were used in the experimental engine and which had an outside diameter of 1¼in. The same spring offered a resistance to bending equal to that of a $^{7}/_{16}$in. solid steel rod.

The compression of the spring is regulated by a nut on the outside of the valve by means of a spindle which passes through the stuffing-box which is provided with a packing of suitable material, as, for

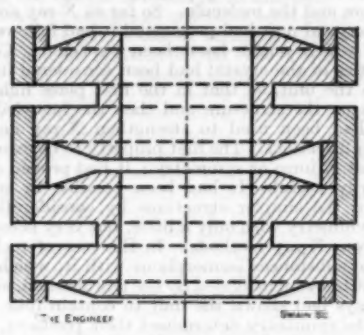


FIG. 6—FUEL VALVE SPRING

instance, lead. There is no difficulty in keeping this packing tight, as the spindle, once adjusted, remains stationary. To diminish the clearance within the valve, the greater part of the space between the spring discs is filled up by washers parted in halves and kept together by a wire. The lower end of the spring is connected to the needle valve, which at a certain point of the engine stroke is opened by the pressure of the fuel and allows the fuel to pass the nozzle and through the fine openings of the burner to enter the cylinder. The main advantages of the valve, as will be easily understood from the above above, are, in the first place, the small inert masses of the valve and, secondly, its freedom from friction, which causes it to work exactly and in perfect response to the varying effective stroke of the fuel pump plunger.

TRIALS OF THE NEW ENGINE.

The experimental engine was a stationary two-cylinder four-cycle engine, rated at 65 brake horse-power with a cylinder diameter of 250 mm. (10in.), a piston stroke of 370 mm. (14½in.), and a normal speed of 300 revolutions per minute. It was placed on a solid foundation and directly connected to a Heenan and Froude hydraulic dynamometer. During the trial the automatic governor was not acting, but the governor lever was locked in a certain fixed position corresponding to the load, and before taking any readings the engine had for a certain time to run under the load in question until a state of permanent stability had been reached.

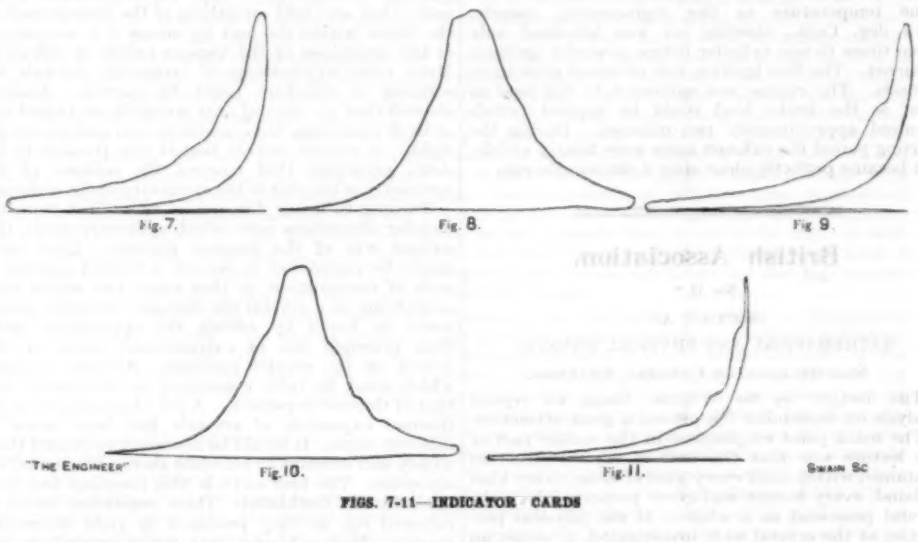
TABLE II.

	Galisol.	Fuel oil.
Specific gravity at 15 deg. Cent.	.856	.894
Calorimetric heating value—		
Calories per kilogramme	10,800	10,710
B.Th.U. per pound	19,440	19,278
Lower or effective heating value—		
Calories per kilogramme	10,090	10,010
B.Th.U. per pound	18,162	18,068
Viscosity Engler—		
At 20 deg. Cent.	—	6.08
At 50 deg. Cent.	—	2.03
Impurities—		
Ashes, per cent.	—	0.04
Asphalt insoluble in ether-alcohol (2 : 1), per cent.	—	0.88
Asphalt, insoluble in ordinary benzine (sp. g. 0.70), per cent.	—	0.27
Solid, mechanical	—	None

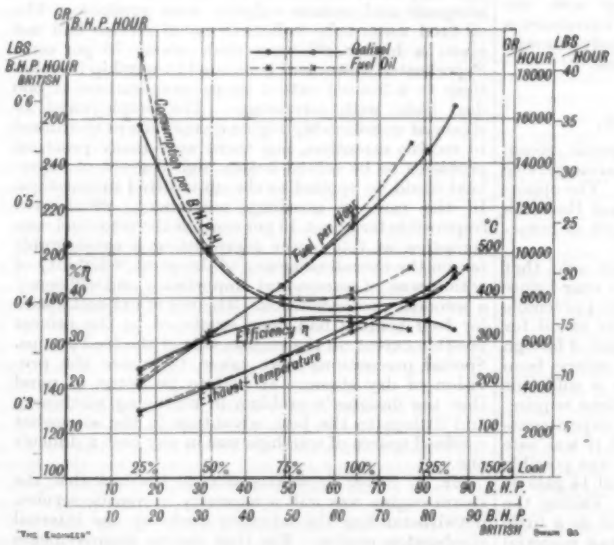
NOTE.—The sample of the fuel oil was passed several times through a fine-meshed wire sieve.

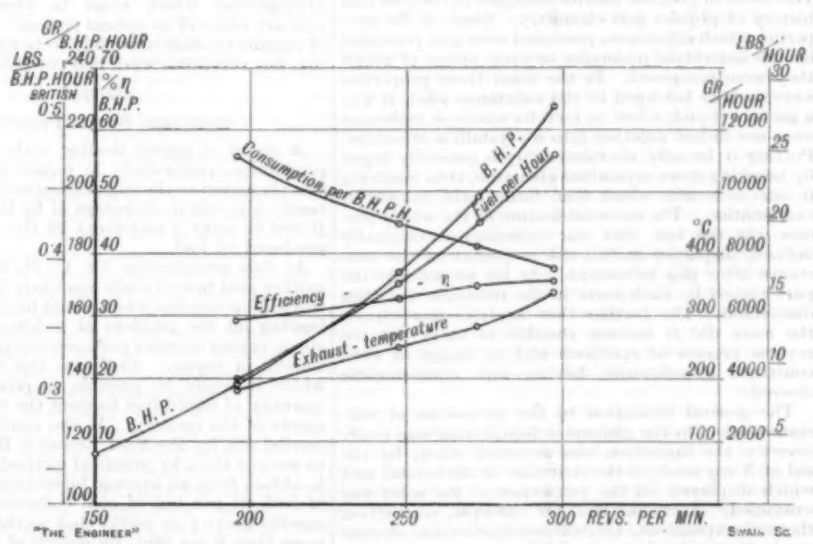
After preliminary trials on February 24th, 1922, the experimental engine was, on March 3rd, 1922, subjected to (1) a series of tests at different loads but constant speed; (2) a series of tests at various speeds; and, finally (3), on March 18th, to a series of trials with "fuel oil."

The oil used during the main trials of March 3rd was so-called "Galisol," a Diesel motor oil. Samples were taken of both kinds of oil and examined at the Government testing station. The results of this examination are shown in Table II.



FIGS. 7-11—INDICATOR CARDS





FIGS. 4 AND 5—RESULTS OF TRIALS

The results of the trials are presented in Table II., and are shown graphically in Figs. 4 and 5.

A number of indicator cards were taken, partly of the ordinary type and partly displaced, with the motion derived from the cam shaft. These cards were not used for computing the indicated horse-power, as the indicator rig was not quite accurate. They are nevertheless shown, as they give a good conception of the working process within the cylinder. Figs.

7 and 8 show cards taken while the engine was running under the maximum overload and developing 86.9 brake horse-power, Figs. 9 and 10 were taken at normal load, 63.7 brake horse-power, and Fig. 11 shows a card taken at quarter load, or 16.2 brake horse-power. Each card represents a number of diagrams, up to twenty explosions, the lines of which perfectly coincide. According to the cards, the pressure at the end of the compression and the beginning of the combustion was 28.5 kilos. per square centimetre, or 405 lb. per square inch, and the highest pressure recorded was 44 kilos. per square centimetre, or 626 lb. per square inch at the maximum overload carried, and 41 kilos. per square centimetre, or 584 lb. per square inch at the rated load.

The overload capacity of the engine is remarkably high. Test No. 1 in Table I. shows a mean effective pressure of no less than 7.24 kilos. per square centimetre, or 105 lb. per square inch, while the fuel consumption remained as low as 190.9 grammes per brake horse-power-hour (.442 lb. per brake horse-power-hour, metric). At the rated load, as well as the three-quarter load, the fuel consumption per brake horse-power-hour is exceedingly low, and practically constant within a wide range.

At all loads, even at the highest overload carried, the exhaust remained perfectly clear and smokeless, and no smell was perceptible. When running the engine on "fuel oil," an efficiency almost as good as when using galisol was obtained, and the exhaust was clear even then.

The starting of the engine was accomplished with ease and perfect reliability. When, on March 3rd, in the morning the engine was perfectly cold, or of the same temperature as the engine-room, namely, 13.5 deg. Cent., starting air was admitted only three times to one cylinder before powerful ignitions occurred. The first ignition was obtained after three seconds. The engine was subjected to full load as soon as the brake load could be applied, which required approximately two minutes. During the starting period the exhaust gases were faintly visible, but became perfectly clear after a six-minute run.

British Association.

No. II.*

SECTION A.

MATHEMATICAL AND PHYSICAL SCIENCE.

Significance of Crystal Analysis.

The lecture by Sir William Bragg on crystal analysis on September 7th proved a great attraction.

The main point emphasised in the earlier part of the lecture was that the unit of crystal structure contained within itself every kind of atom, every kind of bond, every feature and every property which the crystal possessed as a whole. If the physical properties of the crystal were investigated, it meant an investigation of the physical properties of the unit. If the number and the arrangement of the atoms within the unit could be ascertained it might be possible to discover also the part played by each atom in forming the characteristics of the unit or crystal. The methods of X-ray analysis indicated the number of atoms in the unit, and these methods were throwing more and more light on the atomic arrangement. This mode of progress had its analogies in the previous history of physics and chemistry. Some of the properties which substances possessed were also possessed by the individual molecules or even atoms of which they were composed. In the main these properties were such as belonged to the substance when it was a gas or a liquid, when, in fact, its atoms or molecules were not linked together into a crystalline structure. Putting it broadly, chemical analysis generally began by breaking down crystalline structure, thus resolving it into molecules which then formed the subject of examination. The essential feature of the whole process was the fact that the molecule, as originally defined, displayed in full the properties of the substance after this treatment. As far as possible the part played by each atom in the molecule was then discovered. The further that analysis was carried the more did it become possible to carry out the reverse process of synthesis and to design or even construct a substance having any characteristic desired.

The general limitation to the properties of substances when in the gaseous or liquid state was really severe; the limitation was removed when, by the aid of X-ray analysis the structure of the crystal unit which displayed all the properties of the solid was examined. A crystal had, for example, elasticities, thermal expansions, thermal conductivities, electric conductivities, dielectric capacities, optical activities, and so on, which were peculiar to the solid state; moreover, all these qualities were exhibited not only as scaler properties but as vector properties also. For instance, quartz had many properties as a crystal, some of them most remarkable, and they were possessed in full measure by the crystal unit of quartz. It was now known that the unit consisted of three molecules, that it contained three atoms of silicon and six of oxygen, and a knowledge of the relative positions of the nine atoms was now being gained. Investigators were, therefore, in a position to consider the physical properties of the crystal as dependent on the structure of the crystal unit to which structure they owed their existence. The field of research which was opened up was very wide, and it was all new ground. The crystal unit could be compared in its use and very possibly in importance with the atom and the molecule. So far as X-ray analysis of the crystal unit had progressed it had followed the course which might have been expected. Certain properties of the crystal had been considered in relation to the unit, so that in the first place light was thrown on the structure and then the knowledge so given had been used to strengthen X-ray analysis in other directions. The first property to be examined was that of form or symmetry; it had proved extraordinarily useful. It had been possible to analyse some of the simpler structures by consideration of their symmetry with only a little, but very necessary, help from X-ray methods. In the case of rock salt and the substances isomorphous with it, which were the first to be investigated by the new method, as soon as X-rays had shown the unit to contain four molecules the symmetry determined their positions. The same conditions helped in the case of diamond, of fluorspar and of zinc blende. The symmetry in these cases was of high order, but when dealing with crystals of a lower order of symmetry difficulties arose because some of the quantities determining the arrangement could not be found by symmetry considerations alone even when X-ray analysis had shown how many atoms the unit contained.

It must not be forgotten, of course, that X-ray methods revealed more than the dimensions of the unit; they also told something of the arrangement of the atoms within the unit by means of a comparison of the intensities of the various orders of reflection. Many other applications of symmetry towards the solution of structure could be quoted. Analysis showed that the crystal unit generally contained two or more molecules, but sometimes one, and sometimes eight. It seemed certain that it was possible to lay down principles that covered the relation of the symmetry of the unit to the symmetry of the molecule.

Turning to linear dimensions as distinct from the angular dimensions with which symmetry dealt, this subject was of the greatest interest. Each atom might be considered to possess a limited number of radii of combination, so that when two atoms were neighbours in a crystal the distance between centres could be found by adding the appropriate radii. This principle was of extraordinary value in the attack on the crystal problem. Another property which must be fully considered in due course was that of thermal expansion. A few observations on the thermal expansion of crystals had been made at different times. It would be necessary to extend them widely and attempt to correlate them with crystalline structure. The first steps in this direction had been made by Mr. Backhurst. Those researches would be followed up, as they promised to yield interesting results. It was known that many crystalline properties slowly altered with change of temperature. A little work had been done, particularly by Born and Lande, on the connection between the elastic constants of simple crystals like rock salt and its crystalline structure, but there was still a vast field of research open in this direction.

Lastly, there was the question of optical activity. The structure of quartz, for example, showed a spiral arrangement which must be identified with the primary cause of its optical powers. The examination of organic crystals was likely to be extremely interesting, but very little work had yet been done.

SECTION G.

Economic Steam Production.

A group of papers dealing with economic steam production, particularly in regard to marine service was presented to the engineering section. The opportunity was taken advantage of by the Fuel Research Board to make a statement on the subject of home-produced oil fuel.

In this contribution Dr. C. H. Lander said that neither peat nor oil shale was likely in the near future to yield oil supplies which could have any appreciable bearing on the problem of making users of oil for steam raising or other purposes independent of foreign sources of supply. Coal was the only source from which it would be possible to produce a sufficient quantity of liquid fuel to meet the maritime requirements of the country. As the result of experiments carried out by the Fuel Research Board it was safe to assume that, by practical methods, it was possible to obtain from an average bituminous coal 14 gallons of fuel oil per ton of coal carbonised. Taking the specific gravity as unity, that worked out as a little more than 6 per cent. by weight of the raw material used, so that for every 1,000,000 tons of oil produced, 16,000,000 tons of coal must be carbonised, and profitable outlets must be found for about 11,000,000 tons of coke and 56,000,000,000 cubic feet of rich hydrocarbon gas. From these figures it was obvious that the production of fuel oil from coal by low-temperature carbonisation on any adequate scale involved a revolutionary change in the preparation and use of fuel. Even if the more immediate technical and economic problems of low-temperature carbonisation were successfully solved, the wider economic and financial elements involved in the establishment of a new industry on an enormous scale would have to be faced. Should a low-temperature process of carbonisation prove a feasible operation commercially, its first application would probably be to the 35,000,000 tons of coal used for domestic purposes. They would produce about 2,100,000 tons of oil fuel, or considerably more than the peace requirements of the Navy, leaving a quantity which would go far to replenish the tanks of oil-driven steamers when in a home port. Since the greater part of the heat units present in the original coal appeared in the coke, it was necessary for the commercial success of the process that domestic consumers should recognise its superiority to raw coal in the household grate, and that it should be widely adopted by those who were willing to pay a price slightly in excess of that charged for the household coal which it would replace. The commercial and technical solution of the problem was still unproved, but the Fuel Research Board were not without hope that the converging inquiries of a number of experimenters at the present time might lead to a final success. Even in connection with the oil, however, some problems remained to be solved. The flash point of the crude oil was below the Admiralty specification, but it was probable that by column steaming the desired flash point might be reached. The question of miscibility with other fuel oils had an important bearing on the marine problem; but that and other questions would only become of real importance when the stage was reached in which millions of tons of oil were available. The difficulty at the present time was that the coal-distilling industries could not be regarded as the source of greatly increased supplies of fuel oil, and the only means by which the maximum quantity of liquid hydrocarbons could be conserved was by the distillation of the coal at a minimum temperature. Quite recently the work of Dr. Bergius in Germany on the hydrogenation of heavy oils and tars and even on bituminous coal had opened up new possibilities in the production of liquid fuels from coal, it being claimed that those yields could be substantially increased as compared with the output of present methods.

A contribution by Engineer-Commander Fraser Shaw dealt with the employment of auxiliaries with the object of increasing the economy of boiler plant. There was at the present time, he pointed out, a greater disposition to install recording instruments to control the working of the boiler as well as to make use of such auxiliaries as superheaters and economisers. A good installation of Lancashire boilers with these auxiliaries gave an average overall efficiency of 81 per cent., the corresponding figure for water-tube boilers being 83.1 per cent. Inefficient stoking in the case of solid fuel was responsible for appreciable losses in marine service. It was not possible on board ship to use either pulverised fuel or gas fuel.

The naval aspect of the question was discussed by Engineer-Commander R. Beeman. He pointed out that in coal-fired installations, in order to obtain the relatively large steam output, it had been necessary to use forced draught, by which means it was possible to obtain in small water-tube boilers an evaporation of about 10.5 lb. of steam per square foot of heating surface per hour. Mechanical stokers had not proved suitable on warships, nor had it been found possible to use pulverised fuel. Liquid fuel held the field for naval requirements, and its use by the Admiralty had only been limited by the need of ensuring that adequate and certain supplies were available. The oil-fired water-tube boilers in naval service had not given a higher efficiency than about 75 per cent. Superheated steam had been used in warship installations to a limited extent up to temperatures of 500 deg. Fah. with advantage. The employment of steam at considerably higher temperatures continued to receive attention, but there were many practical problems to be solved before high degrees of superheat could be applied to the units fitted in warships. In the case of auxiliary machinery, which was responsible for about 15 per cent. of the total fuel consumption at full power representing a considerable tax on the overall efficiency of the plant, reliability of action was of paramount importance and efficiency a secondary consideration. The use of exhaust steam for feed heating had been employed to the utmost possible extent on the suction side of the feed pumps. Special precautions were taken to ensure the provision of dry steam. It had to be borne in mind that the designer's problem in arranging machinery and fittings to the best advantage in the somewhat confined spaces of warships was in any case a difficult one.

Mr. A. Spyer drew attention to the fact that the steam engine was still a necessity in marine service, notwithstanding the advance made by the internal combustion engine. For that reason improvements in the utilisation of coal, oil or other fuel for producing steam were very keenly sought. It was mainly in the direction of superheating and higher pressures that improvements could be effected. In turbine machinery high temperatures and pressures presented no difficulty, and the main reason why the higher pressures were so little utilised in marine practice was the fact that the cylindrical boiler was not adapted for high pressures or high superheating. Other things which should receive attention were mechanical firing and mechanical draught, and the mechanical handling of the coal to the furnaces and of the waste products.

*No. 1 appeared September 15th.

The root question was the use of the water-tube boiler, prejudice against which was now slowly diminishing in face of the fact that other shipping nations, notably America, Holland, Spain and Italy were obtaining excellent results with water-tube boilers, having modified their methods of manipulation to suit this type of boiler. Statistics of the performance of two sister ships, one fitted with cylindrical boilers, and the other with water-tube boilers, indicated that with water-tube boilers there was a saving of 9.8 per cent. in coal consumption, and owing to the less space occupied the vessel carried 20 per cent. more cargo. The greatest direct commercial gain with solid fuel was to be obtained by the adoption of mechanical methods of feeding the fuel and removing the ash. The question had received the consideration of a leading British shipowner, and an important firm of Dutch owners had recently invited tenders for a vessel in which mechanical coal-handling equipment was to be installed.

Professor J. Henderson, who opened the discussion on the four papers, expressed satisfaction that fuel costs were now, owing to the high price of coal, receiving attention in this country. It was natural, perhaps, but it was a reproach to British practice that in other countries where fuel had never been cheap, so much more had been done in the development of the scientific methods of fuel using.

Mr. C. W. Stromeyer reminded marine engineers that the use of higher pressures and temperatures was not all gain, as the pressures and temperatures now in use in many instances had a detrimental effect, which was more pronounced in land than in marine installations. High temperatures cause trouble with the brickwork and with the tubes. Nor could he accept without qualification the statement of Mr. Spyer that there was no difficulty in using high temperatures and pressures in the steam turbine.

Sir Westcott Abell thought that from the point of view of the tramp owner, who was the backbone of the merchant marine, the choice of machinery lay between the simpler type of coal-fired steam engine, perhaps triple expansion, and the oil engine. The various accessories making for increased efficiency of the plant which were referred to in the papers were very difficult to install and work in an ordinary tramp steamer. The most useful suggestion which had been made was that mechanical stoking should be adopted. It had not been tried on any extensive scale, and there were many difficulties in the way of its adoption, but if they could be overcome it would be a great benefit to those engaged in the operation of coal-fired merchant ships.

Professor Gerald Stoney, while admitting that high pressures had not given any difficulty in steam turbines, said that the use of higher temperatures had been responsible for more trouble than anything else which could be named. It was the difference in temperature between one part of the turbine and another which was the real cause of the troubles which had been experienced, and when superheating was first introduced it became necessary to make modifications in design to meet the new conditions. It was now possible to go up to temperatures of 750 deg. That gave a wide temperature range, and in marine turbines the difficulty had been solved by the use of high and low-pressure cylinders. The trouble with gauge glasses had not yet been overcome. In the high-pressure cylinder it was very necessary to pay special attention to the design of the blading. He would remind the meeting that by the use of an impulse wheel it was possible to obtain a drop of 80 deg. in a single row, and with two rows a drop of 150 deg. Fah., which had the effect of confining the higher temperatures to the small nozzles.

Dr. Lander, replying to some of the points raised, emphasised the fact that the oil fuel problem was not altogether a chemical one; it was also a mechanical question. A real difficulty was that of making reasonably cheap retorts which would stand up to the work. Many types of retort had been proposed for the new system of carbonisation, but the engineer and metallurgist had not yet solved the problem, partly, no doubt, owing to the lack of sufficient knowledge of the behaviour of metals at high temperatures.

Mr. Spyer said that in dealing with oil fuel no reference had been made to the trouble which was likely to be caused by the sulphur content, which had a very deleterious effect on the heating surfaces. He would like to lay stress on the fact that the only way to increase the efficiency of a boiler was to increase the rate of heat transmission and not the rate of combustion. That was a point which was sometimes misunderstood. He could not agree that high temperatures had given trouble in turbine installations, and it was known that in continental practice temperatures of 750 deg. were becoming quite common.

Professor Hudson Beare, in summing up the discussion, said that the question of efficiency had to be regarded from the plant as a whole and not only from the boiler section of it. Tests on boilers did not reveal the overall efficiency of the installation. Another point which had not been sufficiently emphasised was that the use of the various auxiliaries which had been dealt with in the papers submitted reduced the strain on the boiler, and in doing so increased the life and efficiency of the plant.

THE MOTOR SHIP.

In a contribution dealing with the propelling machinery of the cargo-carrier of the future, Mr. James Richardson said that the choice of propelling and deck machinery was of great importance, as it represented from 25 to 40 per cent. of the total cost of the ship, and the economy and certainty of operation of that machinery was a dominant factor in governing the margin between profit and loss.

The Diesel oil engine, as the most economical consumer of liquid fuel, made a strong appeal to the shipowner, and the position of that type of engine was gradually but surely strengthening. Hitherto a reasonably full measure of success in marine service had been limited to conservative types of internal combustion machinery, but to-day newer developments on a bolder scale were gradually proving themselves at sea. The maximum powers for which the Diesel engine could definitely be stated to be suitable were gradually increasing, and to-day 300 brake horse-power per cylinder, with sixteen cylinders, *i.e.*, two engines each of eight cylinders, a total of 4800 brake horse-power, or the equivalent of 5500 steam indicated horse-power total was the standard for the larger class of motor vessel. That range of power covered 96 per cent. in numbers and 88 per cent. in tonnage of ships under construction at the present time, and whilst making all allowances for the fact that the average to-day might give a smaller ship than normal, owing to the limited number of large liners under construction, yet it was seen that the field already covered as regards power was very considerable. Such powers as 5500 equivalent steam indicated horse-power still required twin screws with the Diesel engine. The largest cylinder at sea still remained 700 brake horse-power, but with the particular construction in that case of opposed pistons, the number of cylinders was limited to four. The time was not far distant when Diesel engines of 400 to 500 brake horse-power per cylinder, of various types and in numbers, would be operating at sea with success. Recent advances in materials and design, but more particularly in the latter direction, had succeeded in minimising the heat flow through the material and the consequent stresses induced thereby by means of definitely controlled circulation of the cooling medium, so that with these increases in power, reliability would be unimpaired. The tendency, however, with increasing sizes would be to adopt fresh water cooling both for the pistons, cylinders and cylinder heads, so completely to obviate the chances of local heating and therefore of excessive stressing due to deposits of salt or sand. The extra complication of the coolers, circulated with salt water, for extracting the heat from the fresh water and of the extra pumps was a very minor matter compared with the security so attained.

The Diesel engine still remained a massive and complicated power plant, and no movement towards simplicity had yet definitely set in. Only when marine superintendents and sea-going engineers had attained greater familiarity with the marine internal combustion engine could a number of the "gadgets" at present used as safeguards be discarded, and progress made towards greater simplicity of design. The mass of the engine could only be reduced by increasing the mean effective pressure in the cylinders or the piston speed. The governing factor in the design of all internal combustion engines was the heat flow factor. The greater the cylinder dimensions the more vital was that consideration. That factor, expressed in pounds of fuel consumed per square inch of combustion volume surface per unit of time, was directly dependent upon the piston speed and for a constant factor of heat flow, the lower the piston speed the higher the mean effective pressure possible. The converse was equally true. The tendency for some years past had been to reduce that heat flow factor with increasing size, but the gradual improvements in materials and designs which had permitted of increasing size now allowed augmented heat flow by increasing the mean effective pressure in the cylinders and the piston speed. The piston speed with a single-acting internal combustion engine could well be considerably higher than with steam practice because of two considerations—first, that the maximum pressure for which bearing surfaces are designed was only maintained for approximately 12½ per cent. in the case of four-stroke engines and 25 per cent. of the cycle for two-stroke engines, and, secondly, because the pressures on the bearing and guide surfaces were not reversed as with double-acting steam engines. The inclination, therefore, especially with four-cycle machinery, was to increase piston speed. With twin-screw ships of relatively high speed, revolutions higher than was usual with steam machinery could be adopted without impairing to any serious extent the overall propulsive efficiency. With single-screw vessels, especially of low speed, the propeller speed must be kept low, and long-stroke engines would increasingly be adopted to attain a high piston speed and good propeller efficiency. One point that was not perhaps sufficiently emphasised was that with Diesel machinery the higher the power per cylinder, the greater the weight per horse-power, so that for a given power of ship, there was a definite saving in machinery weights when twin-screw engines were adopted in comparison with single-screw machinery. That saving in weight meant a certain reduction in cost, although the lesser machinery cost was balanced by the increased cost of hull, due to the extra bossing of the stern and the two tunnels for the two lines of shafting. The chief advantage of single-screw machinery lay in the reduction in *personnel* which was possible, as obviously an increased engine-room complement was required to superintend and to manœuvre two engines. Nevertheless, for powers above 2000 to 3000 shaft horse-power twin-screw Diesel engines would be the rule for some time to come and were to be advocated. The saving in fuel costs with Diesel machinery must be considered in conjunction with the lubricating oil consumption, which was higher than with steam machinery. To-day it could confidently be stated, however, that with the latest internal combustion machinery the consumption of lubricating oil had been reduced to a figure of relatively small importance. 1.5 gallons of lubricating oil for all purposes per ton of fuel oil consumed should be the relation, and had been attained. There were good arguments in favour of regarding the machinery of the ship as a central electric power station delivering current to electric motors for propulsion and for other duties. For special-purpose ships, where the duties apart from propulsion consumed a substantial proportion of the total power available, as in dredgers and in cable ships, the Diesel-electric system was being adopted, and merited the closest attention, particularly by virtue of the subdivision possible and the opportunity it gave of applying the Diesel principle to ships of the highest power. On the other hand, it had to be admitted that the first cost of machinery of that type was high, and that electric machinery suitable for marine work could not yet be regarded as reliable as other types of plant. On the subject of higher first cost of motor ships, as compared with steam ships, it had to be borne in mind that a smaller motor ship would suffice owing to the saving effected in the space allotted to machinery, and another advantage was the increased radius of action per ton of fuel as well as decreased *personnel*. On many trade routes it could not be doubted that the extra first cost was quickly written off. When shipbuilding revived the motor ship would be in the forefront. To-day at sea the tonnage of motor ships was 6.5 times more than it was in 1914, and of the present total of motor ships more than one-half, or 848,000 tons, represented vessels of over 3000 tons. Of ships under construction at the present time, those to be engined with internal combustion machinery constituted such a proportion as to make the future for that type appear extremely bright.

Opening the discussion, Professor J. Henderson expressed the opinion that an internal combustion turbine would form a much better solution of the problem of propelling machinery for ships than the Diesel engine type. For the evolution of that form of turbine engineers were only awaiting the discovery of a new metal. Some progress was being made in that direction, and materials were now available which, under red-hot conditions, would maintain their elastic properties. If to that property could be added the retention of tensile strength under conditions of extreme heat the problem of the internal combustion turbine, except for the troubles due to expansion, would have been solved.

Professor Gerald Stoney said the Diesel engine was not yet applicable to large liners, and his own opinion was that there was still a very large field for the old reciprocating engine and also for the turbine for cargo boats. Sooner or later automatic stoking would be used with solid fuel at sea as well as on land, and that improvement would not only reduce the labour in the stokehold, but would bring about a considerable improvement in boiler efficiency. Mr. Richardson had referred to the troubles which had been experienced with double-reduction gears. These gears were still in their infancy, and he would point out that the Diesel engine had also had its teething troubles. Ultimately both the Diesel engine and the geared turbine would cut their second teeth and their troubles would be over. At present it seemed impossible in gear cutting to get the necessary high degree of workmanship to give equal distribution of the stresses. Greater flexibility in the gears was required, and a useful suggestion had been made that a torsional flexible gear should be used. Another plan which had met with a good deal of success was the McAlpine floating frame, and he believed that the solution of the trouble with double-reduction gearing lay in that direction. In a recently constructed Ljüngstrom turbine locomotive a torsional flexible pinion had been introduced to reduce the stresses, and the electric locomotive, which had been built by Brown, Boveri and Co., Limited, had given trouble with the gears until a similar plan was adopted. He agreed that electrical auxiliary machinery should be used to a larger extent at sea, as experience had shown that steam-driven auxiliaries were most extravagant. He would expect to find a preference shown for Diesel-driven electric plant. No doubt the internal combustion turbine would come when metallurgists were able to provide a material which would retain at high temperatures the mechanical properties which good high carbon or nickel steel possessed at ordinary temperatures. Until that material was available a commercial internal combustion turbine could not be made.

Mr. T. Westgarth referred to the internal combustion turbine which M. Rateau had developed for use in aircraft. He thought the trouble would be not only one of materials, but with respect to gearing. The problem of discovering new materials which would

withstand the high temperatures and maintain their mechanical properties was being seriously attacked. Materials were already available which at 800 deg. Cent. had a reasonably high breaking strength, but the time factor was a very important one. Under conditions of steady load with these materials a strength of 10 or 15 tons per square inch could be obtained, but this figure quickly declined under rapid loading conditions, and it was common knowledge that the elastic properties of materials were very seriously affected at temperatures over 500 deg. Cent. He agreed with Mr. Richardson that the Diesel engine had a wide range of application in marine service. He had been closely concerned with the development of that type of engine, and the difficulties which had to be overcome were certainly not more serious than in the case of double-geared turbines. With regard to oil fuel, it was true that it could be obtained at practically any port in the world, but not at the same price, and before deciding to fit a vessel for the use of oil fuel it was necessary to consider the routes on which the ship was to be engaged. The question of auxiliaries on board ship was a most serious one, as they were a source of great loss. Before making any decision the special circumstances of each case must be carefully considered. In the case of an oil carrier, for example, in which it was necessary to keep the tanks warm, a boiler was alway under steam, and in such a case it was preferable to have steam auxiliaries; but no general rule could be laid down.

Professor F. C. Lea said that no reference had been made to the Still engine, which would provide sufficient heat to generate steam for the auxiliaries.

Professor Hudson Beare emphasised the need of ridding ourselves of dependence on foreign sources of supply in connection with oil fuel. The safety of the country demanded that supplies from home sources should be made available, and research must be carried on until that supply could be assured. With regard to materials to withstand the conditions which would exist in an internal combustion turbine, some of the new alloys gave promise, and it seemed possible that some ingredient regarded as an impurity might be found, which, if added in the necessary proportions, would give the desired properties to the metal.

Professor G. W. O. Howe challenged the statement of the author that electrical machinery was unreliable for maritime purposes. He believed that any good firm of electrical engineers could supply plant which would withstand the conditions of sea service.

Mr. Richardson could not agree that the only difficulty which stood in the way of the development of the internal combustion turbine was one of materials. It had to be remembered that the economy of the internal combustion engine arose out of the conditions of combustion, and if an internal combustion turbine was to compete with the Diesel engine it must burn its fuel in very dense air, and it was difficult to see how that end was to be achieved. He was generally in favour of electric auxiliaries.

X-ray Electrons.

Professor R. Whiddington, in a contribution on recent investigations, gave a brief historical review of X-ray electron research. He said it had been known for many years that an approximate relationship existed between the energy carried by the moving electrons within an X-ray tube and the energy possessed by electrons liberated from surfaces illuminated by such a tube. He was able to show some ten years ago that if the heterogeneity of such flights of electrons be disregarded, and only the speediest be considered, then very simple approximate relationships emerged. It might, perhaps, be sufficient to recall that the approximate relationship indicated that an element of atomic weight w emitting both K and L radiations caused electrons of speed up to $w \times 10^8$ cm. per second and $\frac{1}{2}$ $(w - 50)$ 10^8 cm. per second to be emitted from material surfaces on which these radiations were incident. The experimental method was not at the time capable of definitely proving the existence of groups of electrons of less speed, although very recently Simon had succeeded in improving the methods sufficiently to do so. The method depended on the absorption of the electrons in a gas and the measurement of ionisation was frankly an inaccurate one, and a fresh series of experiments, using a different method, with the object of obtaining more accurate results, was commenced in 1920. About the same time, in France, M. de Broglie was engaged in the same investigation, and his (Professor Whiddington's) results, were in general agreement with those of the French worker. The experimental method consisted in illuminating with X-rays of definite wave length a narrow strip of the element under consideration and observing the magnetic spectrum *in vacuo* of the X-ray electrons emitted. The main experimental difficulty was to get sufficiently powerful X-ray illumination. De Broglie used a Coolidge tube, but the author by other methods obtained an even greater intensity. The results of a large number of experiments showed that generally the magnetically dispersed X-ray electrons yielded a line spectrum of comparatively simple appearance. Each line corresponded to a group of X-ray electrons of definite speed. As was to be expected, the position of the lines was definable in terms of the frequency of the incident X-rays and the atomic number of the illuminated atom. It was an atomic phenomenon, and from the position of an X-ray electron spectral line it was possible to deduce the atomic level or ring within the atom from which the electrons were originally ejected.

The Gennevilliers Electric Power Station.

No. III.*

In the Supplement which we publish in this issue views are given of the turbine room, the condensers, the high-tension switch house, and a portion of the boiler-house.

The object of the Union Française d'Electricité is to join together the various distributing companies and to establish large electric generating stations operating under the best conditions. As far as possible it is proposed to standardise a three-phase, 50-cycle supply, and it is intended to relieve the various distributing companies of the necessity for enlarging their generating plants, but to permit them to devote their activities to the development of distribution. Preparations are also to be made for the future use of hydro-electric power.

During the summer of 1919 the Union Française d'Electricité, which was formed during March of the same year, amalgamated with the Compagnie Générale de Distribution d'Energie Electrique and took the name Union d'Electricité, and soon afterwards the company absorbed the Energie Electrique de la Région Parisienne. Before the end of the same year the Union had made definite arrangements with the following companies:—The Triphasé, the Ouest-Lumière, the Secteur de la Rive Gauche, l'Est Lumière, and had acquired the ownership of the generating plants belonging to those companies. At the same time the Union d'Electricité finished making its plans for the Gennevilliers power station and placed orders for the plant. The constructional work on the station was started in the spring of 1920, but it was soon practically stopped by a strike, which delayed the work until the beginning of the summer. Eighteen months later the first generating unit was under test. In the meantime the construction of the Billancourt station and also that of the Issy-les-Moulineaux station was completed. The proposed work already undertaken in the various stations which had been purchased or absorbed was also completed, and more than 100,000 kilowatts of modern turbo generator plant was put into operation in the various stations. This work was undertaken regardless of the construction of the Gennevilliers station in order to meet the increased demands. Simultaneously all the old plant was put in good working condition, thus increasing the efficiency of the old stations.

The Union's distributing systems which are under construction will be fed by the following stations:—The new 200,000-kilowatt station at Gennevilliers, the 48,000-kilowatt stand-by station at Vitry, which will eventually have a capacity of 80,000 kilowatts; two stations at Nanterre and Issy-les-Moulineaux, which the State has the right to re-purchase; the 40,000-kilowatt Eguzon hydro-electric station now under construction; the hydro-electric stations in the centre of France or on the Rhône, which are proposed or in the course of construction; the four stations Alfortville, Asnières, Billancourt, and Puteaux, having a total capacity of 152,000 kilowatts. These latter stations will be put out of service consecutively as the various 40,000 kilowatt units are put into operation at Gennevilliers. The distributing station on the Secteur Electrique de la Rive Gauche de Paris was the first to be shut down.

One of the problems that had to be solved was that of transmitting fairly large quantities of power (varying from 10,000 to 40,000 kilowatts) to the old stations, and as the distribution network spreads approximately 50 kiloms. around Paris, it was necessary to transmit at high pressure; but at the same time it was possible to some extent to employ overhead transmission lines. The Union had to adopt the highest pressure that could be used with safety on underground cables, and the pressure selected was 60,000 volts. All measures were, however, taken to enable this pressure to be reduced to 50,000 volts if necessary.

After a series of tests the decision to use three conductor cables was finally abandoned, for those cables did not allow of a sufficient factor of safety and the cost would have been excessive. It was finally decided to use single-core cables working in groups of three, so as to give three-phase transmission. The insulation is only subjected to the dielectric stress of the voltage between the machine terminals and the neutral, and not that between the lines, the former voltage being $\frac{\sqrt{60,000}}{\sqrt{3}}$.

The system of grouping of the cables also called for careful consideration, and the plan of placing the cables side by side in the same plane as a fourth spare cable was considered to be unsatisfactory. Ultimately it was decided to group the cables in the form of a triangle with their sheathings in contact. Special steps were taken to ensure good insulation, continuity of the lead covers and proper earthing at certain places.

The neutral point of the distribution system is well earthed and the entire system is protected by Merz-Price protective gear, the pilot wires being contained in multi-conductor cables. These pilot cables also serve as telephone circuits, which permit the sub-station attendants to communicate directly with the main station. The total length of the 60,000-volt underground system around Paris will ultimately be 125 kiloms. A large quantity of the feeders has been already supplied by the Compagnie Générale des Câbles de Lyon, at Lyon, and also by the Forges et Ateliers de Constructions Electriques de Jeumont, at Jeumont (Nord). Another important order has been placed, partly with these manufacturers and partly with the Canalisation Electrique, at Saint-Maurice, Seine, and the Maison Geoffroy et Delore. Certain of these firms and the Société Industrielle des Téléphones have also supplied the armoured cables for medium voltage.

The loss due to the induced currents in the lead covers is less than one-sixth of the corresponding copper loss, whilst the dielectric loss in the insulation is approximately 900 watts per kilometre of three-phase feeder.

The distribution system will be completed by a series of overhead lines. There will be four main lines, which radiate from the central part approximately as follows:—

	Length. Kiloms.
Paris-Creil	55
Paris-Mantes	45
Paris-Corbeil-Orleans	110
Paris-Meaux	40
Total length of the overhead lines	250

The section between Paris and Creil is now entirely completed. It comprises two 60,000-volt lines mounted upon single reinforced concrete poles with special structural steel towers for the crossings. The Paris-Mantes line is being laid out. The Paris-Corbeil-Orleans line will be a part of the high-tension system to be installed by the Compagnie des Chemins de Fer d'Orleans to connect the Eguzon hydro-electric station on the Creuse River to the line of the Union d'Electricité. The Eguzon station is being built by the Société l'Union Hydro-Electrique. The Union d'Electricité was interested in the formation of the last-mentioned company and the Compagnie d'Orleans also had an important interest. The Union d'Electricité has been granted, by special arrangement, the general management and the exploitation of the interconnecting system.

As regards the line to Meaux, the preliminary lay-outs are being made. It should also be mentioned that special arrangements have been made so as to permit the installation, at a later date, of incoming lines, now under consideration, for the transmission of hydro-electric power from a great distance. This power will be obtained from the Rhône, the Rhine or the Massif Central.

The study of the operating conditions has raised problems of many kinds, the solution of which has not always been easy. The study of short-circuit currents, to determine the rupturing capacity of the circuit breakers, was made by the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston and the General Electric Company, by the patented experimental method of the latter company. These investigations have taken several months and have necessitated innumerable calculations. The important investigations made by Messrs. Clarke and Shanklin, of the General Electric Company, have been of great assistance in the study of single-conductor cables and especially in the study of the circulating currents in the lead covers. These investigations have been continued in close collaboration with the French cable manufacturers, who have shown, in these circumstances, a keen spirit of initiative. M. Grosselin has taken a personal and particularly active and appreciated part in the work. The study of the phenomena of resonance has been made by M. Emile Brylinski, technical adviser to the company, and he has made many extremely interesting investigations. M. Boucherot has also done work in this direction of the greatest value and has put at the disposal of the Union his exceptional experience and scientific knowledge.

*No. II. appeared September 15th.

For some time past the police, and particularly the Metropolitan police, have been very active in taking proceedings against the drivers of cars on which the number plates are not easily distinguishable. The police contend that the number plates should be fixed in such a position that they do not get splashed with mud in wet weather, and there have been many convictions in cases in which front number plates, by being placed on the front axle, have unavoidably become dirty. In order to obviate the difficulty a number plate has been designed consisting of aluminium letters and numbers which are attached to a piece of wire mesh. This form of plate can be placed on the front of the radiator and does not affect the cooling of the engine to the same extent as a solid plate would. The Metropolitan police, however, have contended that such a plate does not comply with the regulations, because the letters are not on a solid plate, and proceedings were recently taken against the driver of a car with such a front number plate, before the Wimbledon Bench. The case was defended by the legal department of the Royal Automobile Club, and the magistrates dismissed the summons because in their view the spirit of the regulations was not infringed.

A Seven-Day Journal.

Rosyth Dockyard.

IT is reported that the Admiralty has now come to a definite decision as to the future status of Rosyth Dockyard, and that it will eventually become, as originally intended, the foremost dockyard in Great Britain. Considerable developments are planned to take place during the next ten years or so, and we understand that they will include a large amount of constructional work connected with the building of the necessary offices and official residences, the dockyard school, and the provision of housing accommodation for the dockyard workers. For some time it was thought that Rosyth would be maintained as a docking port, and that Port Edgar, on the Forth, as a destroyer base would be closed down. The yard and port are likely to be busy on the occasion of the forthcoming visit of the Atlantic Naval Squadron and the destroyer flotillas to the Forth after the conclusion of the autumn exercises, which are to take place early in October.

Engineering Students' Venture.

WE have often had occasion to refer to the difficulty which is experienced by engineering students who desire to obtain at the end of their college training a post in the works or office, a difficulty greatly increased in these days of industrial depression. Thirteen engineering students of the Loughborough College have, according to the story, overcome this trouble in a romantic way by purchasing from the Ecuador Government an island in the Galapagos Group. They have further acquired a vessel, the Aberdeen steam drifter Productive, which they have rechristened the Wild Goose. Early last week the Wild Goose left Buckie *en route* for the Galapagos, entirely manned by members of the expedition under the leadership of Mr. D. L. David, who is also the ship's captain. The adventurers have the intention of trading in cattle, which they intend to breed, and also in timber, for which purpose they have taken with them a large circular saw bench. We wish these modern de Rougemonts the best of luck and shall be delighted to hear of their safe arrival and subsequent success.

New Motor Lifeboats.

THE Royal National Lifeboat Institution is steadily increasing the number of motor lifeboats in its fleet, and at the present time, out of a total fleet of 241 lifeboats, 37 are boats fitted with motor engines, and a further seven motor lifeboats are under construction. During the year five such boats have been constructed and delivered to their stations, which number does not include the two boats for Bembridge in the Isle of Wight and for the Barry Dock, near Cardiff, which recently underwent successful delivery trials at the Institution's building yard at Cowes. The Bembridge boat is a self-righting vessel, having an overall length of 40ft. and a breadth of 10ft. 6in., and is fitted with a Tylor engine designed to develop 45 horse-power and to give the boat a speed of about 7 knots. The Barry boat is of the Watson type, with dimensions 40ft. by 11ft., and is also fitted with a 45 horse-power Tylor engine. Her designed speed is also 7 knots. This boat is one of two, the other being intended for the Mumbles, near Swansea, for which a special fund is being raised in Glamorganshire.

The Dolcoath Mine.

SOME time ago an application for a loan of £50,000 was made by the management of the Dolcoath Mine, under the Trade Facilities Act, with a view to the restarting of the mine. A scheme of development was laid before the Trade Facilities Committee, and was reported on by an engineer acting on its behalf. It is now announced that the loan will be granted subject to certain conditions, which will be considered at an early date by the directors. We understand that the proportional amount of help promised by the Government under the Act applies specifically to the Roskears scheme of development, under which scheme it is proposed to explore the Roskears group of lodes in granite, which also comprises the South Crofty and East Pool group of lodes. The proposal is to sink a shaft between North and South Roskear, and in the first instance explore the lodes to the south from that point. The reopening of the mine would reduce some of the distress in the district arising from unemployment, and future events are awaited with interest, as the restarting of Dolcoath would probably lead to a general revival of Cornish mining.

Proposed Tyne Improvements.

AT a conference of the North and South Tyneside Joint Town Planning Committee, which was held in Newcastle last week, a report prepared by the engineers and surveyors of the local authorities dealing with proposed means of communications across the Tyne was submitted. The report recommended four crossings, upon which main roads could converge in a co-ordinated town-planning scheme, as follows: (1) In the vicinity of the Scotswood Suspension Bridge; (2) near the High Level Bridge; (3) in the neighbourhood of Bill Quay; (4) at the mouth of the river connecting North Shields and South Shields. At the first three points it is proposed that new bridges should be built, while at the fourth point a tunnel is recommended. The tunnel scheme is favoured by Mr. J. F. Smillie, the borough surveyor of Tynemouth, who regards it as essential that the two Shields boroughs and the adjacent coastal districts should be linked up. The present ferry service is admittedly quite inadequate, and a tunnel would provide the ideal solution, although the engineering problems connected with its construction present some difficulty.

German-built Ore Carriers for America.

IT is reported that Mr. Dan Broström, the well-known Danish shipowner, has contracted with the Deutsche Werft, of Hamburg, for the building of two ore-carrying motor ships, each of 20,000 tons capacity. As now planned, the vessels will have the following dimensions:—Length between perpendiculars, 550ft.; breadth, 72ft.; depth, 44ft. Two Burmeister and Wain type engines, each developing 2250 brake horse-power, will be installed aft. The vessels are to be chartered by the Bethlehem Steel Company for the transport of ore from Chile to New York.

Aero Engines and the Treasury.

AN unfortunate state of affairs has developed in connection with some negotiations between the Air Ministry and the Walthamstow firm of Peter Hooker, Limited. Peter Hookers was, of course, one of the factories which helped the country greatly during the war by turning out Gnome and la Rhone aero-engines, and the output was increased until as many as 300 engines were delivered weekly. Pressure was put on the firm by the Government to increase the output to 500 engines, and just as the necessary equipment was ready the Armistice was declared, and the works were practically shut down. Since then the business has been in the hands of a receiver, but, under the management of Mr. Hedley Thomson, a new aero-engine has been developed in the works, which gives, it is claimed, a greater output for its cylinder capacity than any other engine of its kind. The Air Force is anxious to try the new engine in practice, and appears to be ready to give a trial order, but pleads that a rule of the Treasury does not permit an order being given to a firm in liquidation, and so suggests that the engine should be made by some other company to the drawings of Peter Hooker. Strenuous efforts are, however, being made by all those concerned in the prosperity of Walthamstow to get the Air Ministry to rescind its decision, and in view of the fact that the receiver is ready to offer ample guarantees against loss by the Government, or failure in the completion of the contract, it is to be hoped that the present difficulties will be overcome.

Whitworth Scholarships and Exhibitions.

THE list of successful candidates in this year's competition for Whitworth scholarships and exhibitions has just been issued, and shows that out of fifty-three competitors, four have been awarded scholarships and twenty-two exhibitions. The remaining twenty-seven candidates did not reach a standard sufficiently high to justify the award of an exhibition. It is curious to note that all four scholarships and exactly half of the exhibitions awarded were secured by apprentices at Chatham, Portsmouth or Devonport dockyards. That nearly 58 per cent. of the awards should go to youths in Government establishments seems on the face of things to suggest that Government apprentices have more time or better opportunities for private study than those employed by private firms. The regulations for next year's competition, it may be noticed, have been considerably revised. They are set forth in a pamphlet obtainable from the Stationery Office.

Shipping Losses.

DURING the quarter which ended on March 31st, according to a Lloyd's Register of Shipping return just issued, a total of 130 vessels, with an aggregate tonnage of 124,168, were lost by collision, foundering, wreck or burning, or by being condemned or broken up consequent upon damage by any of these causes. Of the total, 86 vessels, with a tonnage of 99,734, were steam or motor ships, the remainder being sailing vessels. Sixty-four of the vessels were of steel construction, four of iron, two of ferro-concrete, and sixty wooden or composite. On the basis of the total tonnage owned, Germany was the worst sufferer with a loss of 0.74 per cent., Holland being the most fortunate with 0.01 per cent. The United States sustained the heaviest absolute loss with 31,647 tons—0.22 per cent. of the total owned—the United Kingdom being second in this respect with 23,401 tons—0.12 of the total owned. The largest vessel lost during the quarter was the American triple-screw steel steamer Northern Pacific, 8256 tons, which was burnt when on a voyage in ballast.

A Crude Oil Aero Engine.

IT is trustworthily reported that William Beardmore and Co., Limited, acting in conjunction with the Air Ministry, have after lengthy experiments and trials produced a promising type of crude oil aero-engine. The engine has not yet been officially tested, and so far details of its design are withheld. It is understood, however, to be a six-cylinder engine of 750 or 1000 horse-power. It is known that the Air Ministry has for a long time been devoting close attention to the design and construction of engines using fuel other than petrol and similar low flash-point substances. At the Royal Aircraft Establishment experiments have been in progress for a considerable period on the use of shale oil in an engine operating on the Diesel principle. IN addition, the Establishment has been conducting experiments on the solid injection of a fuel containing 95 per cent. of alcohol. In other directions, too, a similar object is being sought, as, for instance, in the case of Dr. Ferranti's experiments on direct injection in a two-stroke cycle engine. The advantage to be gained by discarding petrol as an aero-engine fuel would consist not only of a diminution of the risk of fire as a result of an accident or of the penetration of the tank by a bullet, but also of an economy in running costs.

The Over-production of Rubber.

IN the Journal of June 9th we summarised the findings of the Committee appointed by the Colonial Secretary to inquire into the serious position brought about in the rubber-growing industry as a result of the over-production of the plantations, as compared with the present rate of consumption. The surplus production this year was estimated at 25 per cent. more than the consumption, while, in addition, the stocks in existence last January were 50 per cent. above normal requirements. At a meeting in London last Friday of those interested in the plantation rubber industry, a proposition was considered for the stabilisation of the industry by the creation of an International Plantation Rubber Company, with a capital of about £50,000,000. The total capital invested in the plantation rubber industry is estimated at £150,000,000. Meanwhile, the Colonial Office's Committee still continues to sit. At its last meeting on Monday it investigated various aspects of the scheme for the amelioration of the position by a compulsory policy of restricted output.

A British Colour Index.

UNDER the editorship of Dr. F. M. Rowe, of the Manchester College of Technology, the Society of Dyers and Colourists of Bradford has just issued the first volume of a new "Colour Index" of dyes, designed to replace the hitherto standard work of reference on the subject, Schultz's "Farbstofftabellen." The new work when completed will contain full particulars of about 1400 individually distinct colours, or some 400 more than the number found in the last, 1914, edition of Schultz's work. The "Index" will give the constituents, method of preparation, properties and alternative trade names of the commercially made dyestuffs produced by over a hundred dyemakers all over the world. The proofs of the work have been revised by all the colour manufacturers concerned, except those in Germany, who as a body refused to co-operate. That Germany has lost her dominant position in the dye industry is evidenced by the fact that arrayed against her thirty-two firms of dyemakers, there are now an equal number in this country, twenty-nine in the United States, seventeen in France, and fourteen in other countries.

Farm Tractor Dangers.

THE danger which in certain circumstances may attend the operation of certain types of agricultural tractors is illustrated by an accident—not the first of its kind—which occurred recently at Whitney in Herefordshire. At the inquest it was revealed that the operator was killed by the tractor turning a backward somersault upon him. The theory accepted was that the cultivator had been attached to the tractor with the line of pull of the chain at too high a level, with the result that the tines were driven deeply into the soil and formed an anchor for the back axle, about which the front portion of the tractor climbed round until it fell over on to the cultivator. It is a common experience with some tractors to find the front wheels lifting off the ground in this way. The natural remedy is to free the clutch, but it is clear that if there is any delay or failure in doing so a dangerous situation may quickly arise. In many designs of tractors, of course, the driving gear is so arranged that the possibility of the machine climbing round the back axle does not exist.

A Successful Mining Enterprise in China.

THE KAILAN MINING ADMINISTRATION.

THE Kailan Mining Administration was formed by an amalgamation of the interests of the Chinese Engineering and Mining Company, Limited, a British company registered in London, and the Lanchow Mining Company, a purely Chinese company operating under the laws of China. This working agreement was entered into in 1912, after many years of friction and cut-throat competition between the respective parties, and stands out to-day as a complete justification for co-operation between British and Chinese interests. The aggregate paid-up capital of the two companies amounts to two million pounds, whilst £1,200,000 has been raised on 6 per cent. first mortgage debentures known as "Kailan Bonds," which are being redeemed at the rate of £24,000 per annum.

The head office of the Kailan Mining Administration is at Tientsin, and the coal mining concession is situated in the Kaiping district of the province of Chihli, North China—see the accompanying map,

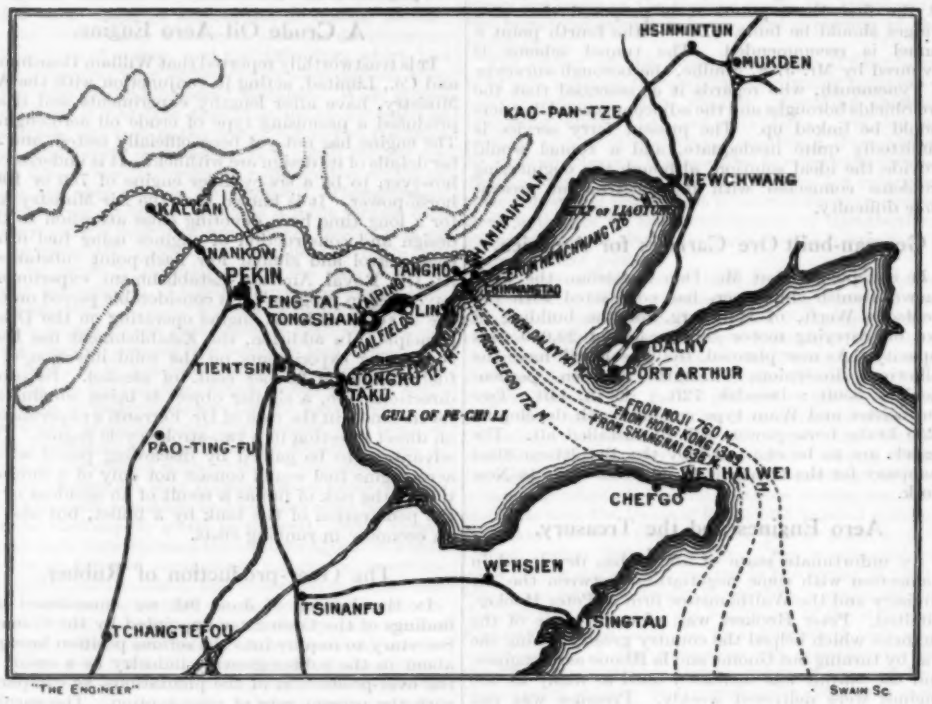


FIG. 1—SITUATION OF THE KAIPING COALFIELDS

opposition that communication was eventually made with the head of the canal by a railway operated by steam. This six-mile line was the first railway constructed in the northern half of the Chinese Empire, and became the nucleus of the Peking-Mukden Railway, now the most prosperous railway in the Republic.

For some twenty years the overseas demand for coal was met through this channel, but the increasing trade, together with the delays and uncertainties incidental to navigating the Taku Bar, obliged the Chinese Engineering and Mining Company, Limited, to avail itself of the extending railway system to seek a deep-sea and protected port elsewhere. The choice fell upon Chinwangtao—see Figs. 1 and 2—and time has proved that a more suitable site could not have been selected. A short private railway for many years connected the port with the main line, but so great has been the growth of traffic that the Government has been induced to divert the main line of the Peking-Mukden Railway so as to obtain direct communication with the port. From its geographical position, Chinwangtao is the natural inlet and outlet for the north-western part of the province of Chihli, and has the great advantage of being practically ice-free throughout the year.

FIG. 2—PORT OF CHINWANGTAO

Fig. 1. The mines are served by the Peking-Mukden Railway, which connects them with Tientsin, a great trade centre of over 800,000 inhabitants, 81 miles away, and Peking, at a distance of 160 miles. To the river port of Tongku (for Taku Bar) and to the deep-water port of Chinwangtao the distances are 50 and 80 miles respectively. At Tongku the Administration has a large stacking yard and wharf for the bunkering of ships running to Tientsin or Taku Bar. The port of Chinwangtao is situated on the western coast of the Liaotung Gulf, latitude 39 deg. 55 N. and longitude 119 deg. 38 E. Chinwangtao, translated literally, means the Island of the Chin Emperor. Historians record that the Emperor Shih Huang Te, of the Chin Dynasty, directed the building of the Great Wall of China from this island about the year B.C. 331. Deposits of silt from mountain streams, combined with the movement of sand from the sea, have long since joined the island with the mainland. The earliest attempts of the collieries to reach the seaboard was by means of a shallow canal extending some 35 miles to the mouth of the Pei Ho, better known as the Tientsin River. Engineering difficulties prevented the close approach of the canal to Tongshan Colliery, and it was in the face of deep-rooted official

TONGSHAN COLLIERY.

In very early times the natives of the Kaiping district contented themselves with quarrying the outcrop coal, and it is recorded that coal was mined by these primitive methods at Tongshan during the later years of the Ming Dynasty, or some three hundred years ago. Modern methods of working were first introduced in 1878 at Tongshan mine, this being the first occasion that foreign mining methods were adopted in China. Three large shafts of 14ft. to 16ft. diameter have now been carried to a maximum depth of 500 yards, and the capacity of the present equipment is fully 2000 tons per day. The principal engineering workshops have been established at this colliery, where all the heavier repair work, as well as a large amount of manufacture, are carried on. The shops are capable of turning out heavy castings, centrifugal pumps, ventilating fans, railway cars, headstead gear and generally all the minor engineering and fitting work required about the mines. The main workshops, &c., are now in course of transference to Linsi.

MA CHIA KO COLLIERY.

The Ma Chia Ko Colliery—see Fig. 4, page 297—has a maximum daily capacity of 2500 tons.

CHAO KO CHWANG.

Like Ma Chia Ko, the Chao Ko Chwang Colliery—see Fig. 5, page 297—is comparatively new and the workings have obtained a maximum depth of only 300 yards, from which level coal is delivered through three shafts of 13ft. to 15ft. diameter. The output of this colliery is, however, greater than any mine outside America. At present 5500 tons of coal a day are produced, and it is anticipated that very shortly the output will reach 6500 tons daily.

LINSI COLLIERY.

The Linsi Mine—see Figs. 6 and 7, page 297—is the main centre for production of power. At it is also situated the washing plant, where the lower grades of coal are cleaned. The output of this mine is at present 3500 tons a day and will shortly be increased to 4500 tons. The two vertical shafts of 14ft. and 15ft. diameter have been carried to a depth of 333 yards. The washing plant has been in service since 1915 and is capable of treating 100 to 150 tons of coal per hour, the quantity varying according to the grade of coal being washed.

GENERAL EQUIPMENT.

The equipment of the mines generally is of the most modern type and will compare favourably with the largest and best-equipped collieries of Europe or America. Electrical machinery is used throughout. There are over 200 electric motors and over 100 transformers in daily use. Practically the only service performed by steam engines direct is the actual raising of coal, and it is now proposed to replace five of the existing winding engines by large electrically driven machines. The boilers in use at the various power stations have an aggregate heating surface of over 60,000ft. and consume over 300 tons of coal daily. Mechanical stokers are in general use, and within a short time hand stoking will be entirely abolished. For surface transport and shunting fifteen locomotives are employed and 340 wagons with a capacity of over 4000 tons. Haulage underground is effected by 1100 mules and 6000 coal tubs with a capacity of over

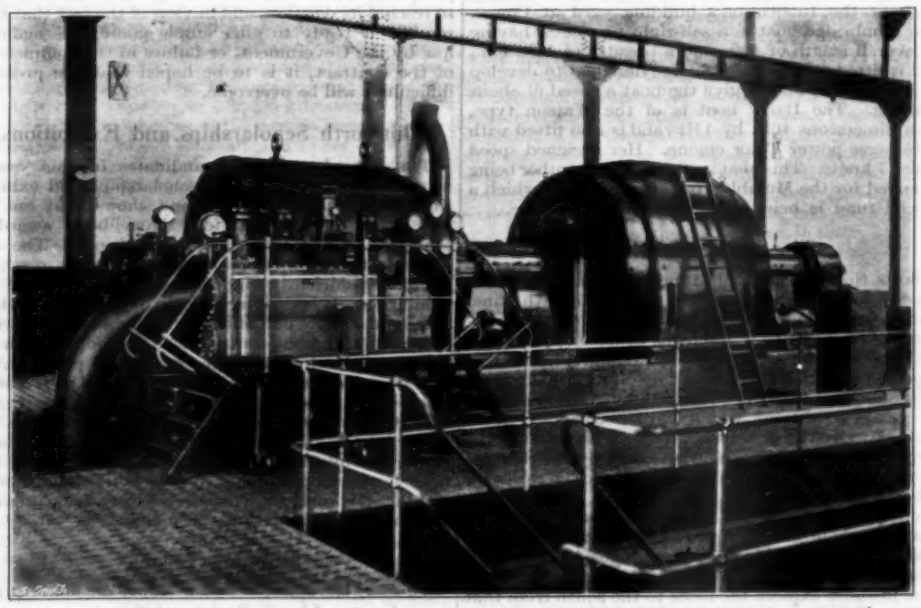


FIG. 3—3000-K.W. TURBO ALTERNATOR, LINSI COLLIERY

CHINESE MINES OF THE KAILAN MINING ADMINISTRATION

(*For description see page* 296)

FIG. 4—MA CHIA KO COLLIERY

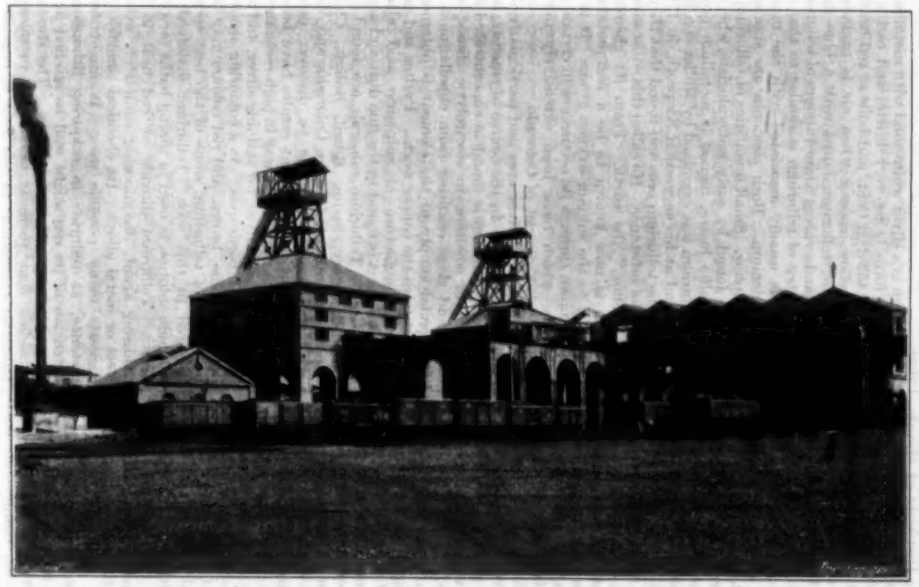
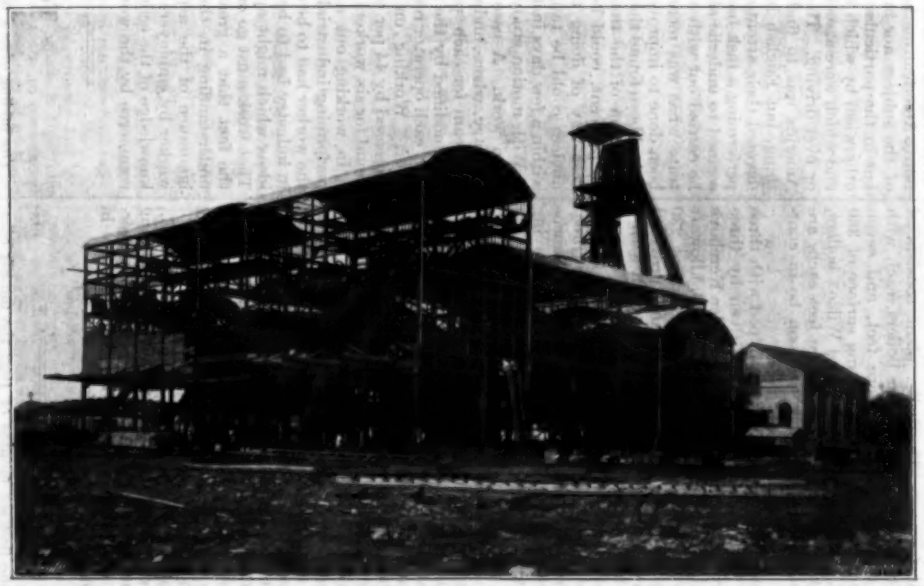
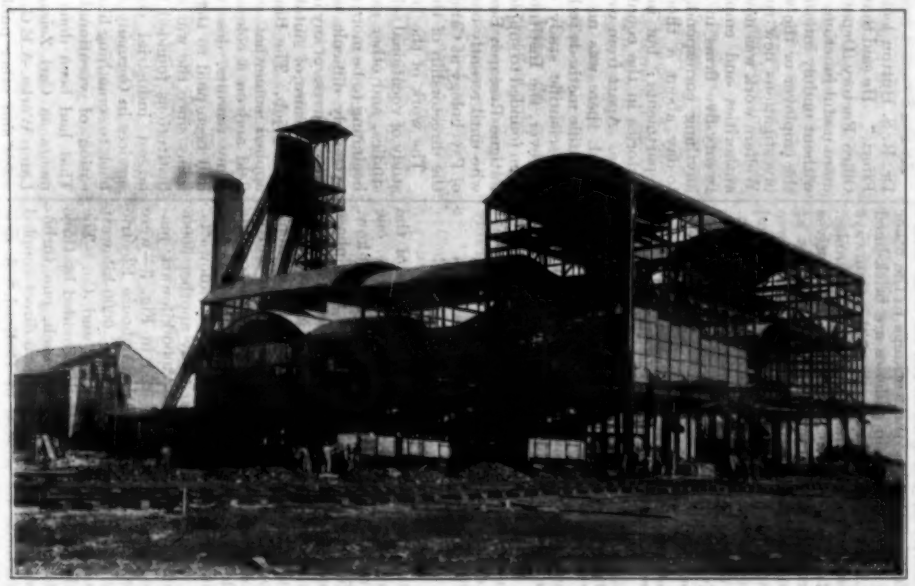


FIG. 5—CHAO KO CHWANG COLLIERY





FIGS. 6 AND 7—HEAPSTEAD AT THE LINSI COLLIERY

2400 tons. Tramways for the haulage of coal underground constitute at each mine a very complete system, all main mule roads being double tracked throughout their entire length, and in the older mines extending from one end of the workings to the other for over 3½ miles. All main galleries are brick-lined throughout. The aggregate length of the tramways at present in use underground is more than 300 miles. The substitution of electric or benzine locomotives for underground traction in place of the mules at present in use is being considered. The labour force employed amounts to 15,000 men underground and 7000 on the surface, or a total of over 22,000 men. Some idea of the mines' requirements of materials may be given by the following figures of annual consumption :—

Clinker bricks (manufactured by the Administration and used mostly underground)	15,000,000
Dynamite	50 tons
Other explosives	25 tons
Mining timber to the value of	£60,000
Structural steel and iron to the value of	£30,000

A new mine, which is now being equipped at Tang Chia Chwang, between Chao Ko Chwang and Linsi, is designed for a daily output of from 4000 to 5000 tons. With this mine in full working order the output from the Administration's mines should considerably exceed 20,000 tons per diem.

Electric Power.

The electric power for the various services of the mines is produced in three generating stations, one at Linsi, one at Tongshan, and one at Machiakow. The two first-named stations produce three-phase current, frequency 25, used at all mines; whereas Machiakow generates at 50 periods for a few motors at that mine in case of accident at the other stations. Linsi station is the main generating station and at present is equipped with two turbo-alternator sets of 3000 kilowatts each, one turbo-alternator set of 6000 kilowatts, and one alternator of 1040 kilowatts. This latter will shortly be replaced by another 6000-kilowatt turbo-alternator. The 3000-kilowatt machines—one of which is illustrated in Fig. 3—were manufactured by the British Westinghouse Electric Manufacturing Company, and the 6000-kilowatt turbo-alternator by Brown, Boveri and Co. The power for the various auxiliaries is provided by three motor generators of 25 kilowatts each, one turbo-generator set of 30 kilowatts, and two direct-coupled sets manufactured by Allens, of Bedford. A new switchboard, manufactured by Brown, Boveri and Co., is being installed to take the place of the old one. Power from this station is transmitted direct to the Linsi Mine at 2200 volts and to the other mines through a sub-station, where it is stepped up from 2200 to 30,000 volts. This sub-station at present comprises three 1500-kilovolt-ampère British Westinghouse transformers, but it is the intention of the Administration to replace the latter by four 4500-kilovolt-ampère transformers. The boiler plant consists of four Babcock and Wilcox tubular boilers, each with a heating surface of 1500 square feet, and seven Galloway boilers, each with a heating surface of 360 square feet. Eight new Babcock and Wilcox boilers, with a heating surface of 2000 square feet each, are being installed, four of which will soon be in commission.

The Tongshan power station is equipped with three alternators of 1040 kilowatts each, driven by three horizontal compound engines of the Van den Kerchove type. The auxiliaries consist of one 30-kilowatt turbo-generating set supplying direct current at 230 volts, and three rotary converters. Steam is provided by a battery of fifteen Galloway boilers, each with a heating surface of 360 square feet.

The Machiakow generating station, which is only used in case of emergency, is equipped with one three-phase alternator set of 1000 kilowatts. Seven Lancashire boilers are installed at this station, each having a heating surface of 360 square feet.

Shipping Facilities.

Shipping plays an important part in the affairs of the Administration. At the present time twenty-six steamers carry coal under the Administration's flag—a number rather below the average usually maintained, which is about thirty bottoms. The capacity of the port of Chinwangtao is from 10,000 to 12,000 tons per day, the work of bunkering and loading the ships being performed by manual labour. It is the general experience throughout the Far East that mechanical loading devices will not compete with Chinese manual labour, and the Administration finds it advantageous to employ Chinese coolies for the loading and bunkering of ships. The services are at all times available of at least 3000 men, who are housed within easy reach of the harbour of Chinwangtao.

Our thanks are due to Major W. S. Nathan, R.E., C.M.G., the general manager of the Kailan Mining Administration, and Mr. A. Docquier, the engineer-in-chief of the Administration, for their courtesy in supplying us with the above information.

During the first six months of 1922 the mining companies of Melilla, Morocco, exported over 100,000 tons of iron ore, of which the bulk went to Germany. It seems clear that these exports have decreased to a proportionate extent the sales of iron ore at Bilbao and Santander.

The Science of Human Effort.

At the Swansea meeting of the Institute of Metals, Dr. R. S. Hutton lectured on the "Science of Human Effort." He said that during recent years the Home Office Factory Department had endeavoured to fill more useful functions than that of mere police duties without unduly interfering with the freedom of either the employer or the worker. As the result of recent investigations new rules were now being drawn up. Welfare work was now receiving more attention from authorities and employers. Before the war only twenty-five firms in Great Britain had established anything corresponding to a welfare department; to-day about a thousand firms had formed such departments; but inasmuch as there were 282,000 factories in the country, much still remained to be done. Apart from welfare work as ordinarily understood, there was no doubt that the application of scientific methods to human effort had lagged behind the scientific study of materials. Quite recently, however, the Institute of Industrial Psychology had been founded to supplement the work of the Industrial Fatigue Research Board, and Professor C. S. Myers, who until recently occupied the position of Professor of Psychology at Cambridge University, had accepted the directorship of the Institute.

The work of the Institute had been directed to a study of vocational selection, fatigue, time and motion studies, and other aspects of the question. It was beginning to be more and more realised that it was an extremely difficult task to determine the probable future success of any individual or to gauge in advance the measure of suitability of a worker for any particular job. The Binet-Simon test, which had been applied somewhat extensively in the educational field and on a colossal scale in America in grading army recruits, deserved mention. Much attention had been paid to that branch of psychology in Germany since the war at technical schools and special institutions founded for the purpose. Some of the largest industrial corporations and public utility services in Germany ascribed their success in getting back to something like pre-war efficiency to the application of vocational selection and motion study. That had been done at such well-known establishments as Carl Zeiss, Siemens and Halske, Osram Lamp Works, A.E.G., and Krupps, as well as on railways and other public works. In connection with fatigue studies a vast field had to be covered, including hours of labour, workers' environment, methods of work, physical condition of worker, rest pauses, and other factors. No simple test could be devised by which fatigue could be measured, but sufficient was known of the subject to make it possible to distinguish between healthy fatigue and its more detrimental and permanent occurrence.

With regard to time and motion study, the real objection to American methods lay, not in their detailed study of the subject nor in the specification of movement, but in the particular forms of stimulus (payment or otherwise) by which it was sought to increase output and which were associated with a sense of "bossing" or over-driving. The basic idea of motion study in America was to find the speediest way of doing a thing, but English investigators of the subject had devoted their attention to finding the easiest way of performing a task based on the innate rhythm which seemed to underlie all human actions if they were to be carried out with a minimum of fatigue. To illustrate what was meant he would refer to what had been done to improve the process of metal polishing. It had been found that by a careful study a percentage reduction of the time occupied ranging from 26 to 35 per cent. could be achieved, and that when the best way of doing the work had been ascertained novices could be taught to earn the standard wage within a few days instead of many months.

With motion study was bound up the question of team work. A case in point was the shoemaking industry, where, under the original system of working, the team for each press consisted of two girls. It was modified by the introduction of a third hand so that each operator rested for twenty minutes in every hour. Working on this system the output was increased by 44 per cent. and employment was being found for six workers instead of four.

In working out a comparatively new system of performing industrial operations the conservatism of the worker had to be overcome, and all those engaged in industry had to be educated to accept as practical ideas which might appear to be impossible idealism. That work must go on. Finally, he would emphasise the fact that a great deal of the present-day misunderstanding in the industrial world was due to ignorance of the aspirations and mentality of the worker by employers quite as much as to the lack of knowledge of the economic principles of industry and commerce by the worker.

Tellurium.

The finding of new uses for the mineral tellurium would render marketable a by-product of which the copper refineries of the United States alone can produce 125,000 lb. annually, but for which there is at present little demand. The United States Bureau of Mines has recently concluded a study of the subject and has reached the general finding that, although the mineral possesses various rather remarkable characteristics, present uses are so limited that the demand is supplied by a few hundred pounds per year.

Tellurium is a silver white solid with metallic lustre, the crystalline form being very brittle and easily powdered. It melts at 452 deg. Cent. and boils at red heat, giving off a golden yellow vapour when air is excluded. When heated in air, tellurium burns with a blue flame tinged with green and evolves white vapours of tellurium dioxide. The chemistry of tellurium is similar to that of sulphur. Tellurium is usually associated with the more common element selenium. Both elements are similar in many ways to sulphur. Small quantities of tellurium in the free state were found by early mineralogists, who, on account of its metallic lustre, named it metallum problematum. Native tellurium was examined by Müller von Rechenstein in 1782, and at his suggestion Klaproth, in 1798, made a study of the tellurium ores and found that they contained a metal-like substance. He called this substance tellurium, from "tellus," the earth. From its chemical nature, tellurium is now known to be a non-metallic element, belonging to the sulphur-oxygen group. It is most commonly known through its occurrence in certain gold ores—tellurides—which have been extensively mined in the Cripple Creek district of Colorado.

Most gold and silver ores and particularly copper ores contain tellurium. In the course of smelting and refining these ores tellurium is found in concentrated form in the flue dust of smelters, in electrolytic slimes, and in the fumes and slags resulting from cupellation. The whole commercial supply of the element is obtained as a by-product from the copper works. Pyrites and sulphur used in the manufacture of sulphuric acid also contains tellurium, as it is found in the flue dust and acid sludge of acid plants. Tellurium minerals are found in Tranasylvania, Hungary, Spain, Brazil, Bolivia, Chili, Mexico, Japan, Australia, California, Colorado, and Virginia.

Efforts have been made to discover new uses for tellurium, but no important results have been reported. It has been used in a small way in high-resistance and other alloys, in organic dyes, for staining silver, and as a reagent in chemical laboratories. As a colouring agent in glass or porcelain, blue, brown, and red colours may be produced by means of tellurium, some of the best ceramics being coloured in this way. Tellurium dissolved in sodium sulphide solution is used in toning baths for photographic prints. Tellurium dioxide at red heat is a powerful oxidising agent, decomposing completely even lumps of steel or metal alloys. Its chemical similarity to sulphur suggests many possible uses. It might be used, for instance, as telluride in colouring lithophone, and the extension of its use might well be studied in connection with the iron and steel industry. The Bureau of Mines considers that there is undoubted promise in certain tellurium compounds in the field of organic medicinals, while in compounds similar to selenium oxychloride tellurium may provide valuable laboratory reagents. The use of two-tenths of 1 per cent. diethyl telluride in petrol as an anti-knock compound has been reported. It is said to eliminate carbon deposits and to produce greatly increased efficiency when used in motors designed to operate on very high compression. A special type of engine is said to be required to produce these results, so that its general use in motors will not be practicable unless the motor industry should conform to the required type. This step in turn would be dependent on a supply of tellurium adequate to treat all the motor fuel. For this purpose 1500 tons of tellurium per year would be required, and as the possible annual supply of tellurium from the present sources is said to be only about 125,000 lb., a much larger supply would have to be developed.

Tellurium is usually offered in the impure state, and no market standards have been developed. No ores are known that are rich enough in tellurium to permit mining and treatment for tellurium alone, even if the demand increased to large proportions, so that it is probable that the future supply will be derived as a by-product from metallurgical processes as in the past. Samples of tellurium for research purposes may be obtained from the Committee on the Uses of Selenium and Tellurium, National Research Council, Washington, D.C. Detailed information regarding the properties, uses, and metallurgy of the substance is given in a publication, Serial 2385, by H. A. Doerner, which may be obtained from the Bureau of Mines, Washington, D.C.

RAILWAY DEVELOPMENTS IN ARGENTINA.

The Argentine Government has purchased for the sum of 1,950,000 dols. gold, or approximately £400,000, the entire property of the Central Chubut Railway Company, a British concern which owns about 65 miles of line between Port Madryn and Trelew, in the territory of Chubut, Patagonia. Included in the purchase are all rolling stock and equipment, workshops, buildings and terminal facilities at Port Madryn, and the company's right to a strip of land for extensions. The Government proposes to make the line part of its system of light railways for the development of Patagonia, and later on will extend it right through the Chubut territory to Colonia 15 de Octubre, near the Andes. Further north the State Railway Department is pushing on with the line through the Rio Negro Territory from San Antonio to Lake Nahuel, Huapi. A good deal of construction work has been done, and recently twenty-five American locomotives arrived for service on the new line. It has now been decided to prolong the line as far as San Carlos de Bariloche at the foot of the Andes, and on the Atlantic side to extend it from the port of San Antonio east to Viedma, where it will link up with the light railway system of the Great Southern Railway Company. While private railway companies in Argentina are showing no disposition to extend their systems, the Federal Government is embarking on a vigorous policy of construction. Patagonia is to have a whole network of light lines, and the agreement of last April between Chile and Argentina provides for the building of connecting links that will create two more transcontinental routes.

Railway Matters.

THE Cambrian Railways having been amalgamated into the Great Western Group, Mr. G. C. McDonald, the chief engineer and locomotive superintendent, and Mr. James Williamson, the assistant engineer, have retired.

THE Victorian Railway Commissioners desire to publish a brief railway history of Victoria from the opening of the line, 2 miles in length, from Flinders-street, Melbourne, to Sandridge—now Port Melbourne—in 1854 to the present time.

FOR the first time in their history the receipts for 1921 of the Gold Coast Railways did not balance the expenditure and interest on capital. This was mainly due to interest at 6 per cent. having to be found on the capital expenditure of £2,200,000 for the construction and equipment of the Tafo-Coomassie extension.

AS successor to Mr. Bowman Malcolm, as engineer and locomotive engineer, the Northern Counties Committee of the Midland Railway has promoted Mr. W. K. Wallace, whose engineering assistant will be Mr. F. W. Crofts, with Mr. H. P. Stewart as his mechanical assistant. The changes come into force on October 1st.

RUMOUR was busy last week as to an early reduction in railway fares. For the reasons given in our leading article of August 11th, we do not anticipate any further change in railway charges during the present year. Grouping must be an accomplished fact before the companies will do anything that will reduce their receipts.

AT the request of the Association of British Chambers of Commerce, the Cunard Steamship Company arranged that for the portion of the year during which the Atlantic liners used the short ocean track, its east-bound steamers should call at Plymouth and would land mails if circumstances permitted. It was announced that the Mauretania, which left New York on the 5th instant, would inaugurate the arrangement, but as a matter of fact she did not do so.

IN this column on June 30th we quoted the chairman of the Great Indian Peninsula Railway as saying that he hoped the Government would make a decision shortly as to the electrification of the Bombay suburban lines. As soon as a favourable decision was made the company would get on with the new branch to Bombay Harbour. The electrification was an absolute necessity if the development scheme of the Bombay Government was to be a success. It is now announced that the electrification has been sanctioned.

THE London, Chatham and Dover Railway had, long before the fusion with the South-Eastern, been equipped throughout with Sykes' lock and block, but this system of trains controlling the block signals and the block signals controlling the outdoor signals was not adopted to the same extent on the South-Eastern. The line where the fatal accident of the 21st ultimo occurred was part of the South-Eastern, and had not the Sykes system. Had it occurred at Gravesend there would have been positive proof whether or not the signalman lowered his advanced starting signal.

A COMMISSION of British engineers has arrived at Santander for the purpose of studying the construction of a projected railway line between Santander and Calatayud *vid* Burgos and Soria. It is said that the engineers are the official representatives of a wealthy financial syndicate. The investigations are to be made without haste and minutely, commencing at Santander and terminating at Calatayud. It is estimated that the cost of the new line may amount to over 200,000,000 pesetas. The most difficult section of the line will be that between Ontaneda and Burgos, for in this section it will be necessary to construct twelve long tunnels. The line will be of broad gauge and probably double. It is hoped to obtain Government assistance for the project.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first seven months of the present year was as follows, the corresponding figures for 1921 and 1920 being added in brackets :—Locomotives, £3,054,709 (£4,424,109, £2,977,655); rails, £1,585,639 (£1,828,962, £1,387,030); carriages, £952,377 (£899,818, £851,270); wagons, £2,108,953 (£3,425,245, £3,195,889); wheels and axles, £847,199 (£1,203,229, £1,131,533); tires and axles, £266,472 (£913,598, £764,791); chairs and metal sleepers, £1,422,821 (£761,963, £448,851); miscellaneous permanent way, £894,559 (£1,660,199, £1,394,349); total permanent way, £5,144,075 (£6,520,520, £5,180,745). The weight of the rails exported was 154,287 tons (82,900 tons, 73,746 tons), and of the chairs and metal sleepers, 101,465 tons (30,328 tons, 21,021 tons).

THE useful innovation of a Pullman restaurant car on the Highland Railway, mentioned in this column on June 9th, has led to two other cars being provided during the tourist season. They are likely to be greatly appreciated, as it has hitherto been very difficult to get any substantial refreshment between Perth and Inverness. The original car starts from and returns to Glasgow, Buchanan-street, and goes north from Perth on the express at 11.50. It is taken off at Aviemore and returns thence at 4.50 on the 3.30 from Inverness. One of the additional cars leaves Perth by a semi-fast train at 12 for Aviemore, and returns to Perth on the second, or West Coast, portion of the 4.30 from Inverness. The other leaves Edinburgh, Waverley, at 2.10 and Perth at 3.50 for Blair Atholl, and returns thence on the first, or East Coast, portion of the 4.30 from Inverness.

IN the Engineering Notes for August, which appeared in our issue of the 1st inst., we just touched on the inclusion of the Great Central in the Eastern, North-Eastern and West Scottish group. Not only has the Great Central its own line to Manchester, Oldham and Wigan, but, as a third-owner of the Cheshire Lines, reaches Liverpool, which in itself has great potentialities. By the same means it reaches Warrington and Chester, and from the latter point has its own line to Birkenhead. Then it has as good a route as the Midland between London, Leicester, Nottingham and Sheffield, which, moreover, is a road over the greater part of which much more traffic can be carried than is the case to-day. Finally, there is the connection with the Great Western at Banbury. The Great Central, then, is likely to be a very valuable acquisition to the Eastern Group.

Notes and Memoranda.

ACCORDING to H.M. Senior Trade Commissioner at Calcutta the total imports of merchandise into India for the three months April-June declined from 66 crores of rupees, in 1921, to 53 crores, in the corresponding period of the present year. It is satisfactory to note that the United Kingdom increased its share from 58 to 62 per cent., as contrasted with a reduction in the share of the United States from 11.6 to 7 per cent., and in the case of Japan from 6.7 to 5 per cent. German shipments, however, rose from 1.9 to 5.7 per cent., and those from Belgium from 2.2 to 2.7 per cent.

IN Holland miniature circuit breakers are employed to a considerable extent on domestic and industrial circuits, feeding lamps, small motors, &c. They are adjustable for loads from 6 to 25 ampères at pressures up to 250 volts, and are reset by turning a handle like that of a rotary snap switch. An indicator shows when a breaker has opened. Such circuit breakers are used in place of main fuses where the cables enter a house; they are sealed to prevent alteration of the setting, but can be reset by the consumer. They are also used for the separate circuits instead of fuses. The mechanism is very simple and not liable to get out of order.

A SPRAYING nozzle, for aerating water, has been evolved by the engineers of the Sacramento water supply department which possesses the advantage that its effectiveness is not naturally affected by the head under which it works. The nozzle merely consists of a conical orifice 4in. in diameter fixed on the end of a 2in. pipe. Inside the opening there is loosely placed another solid cone, 2¾in. diameter, weighing 2 lb. The angle of both cones is 60 deg., while a short length ¾in. pipe hangs below the inner cone to steady it. The spray is effective for heads ranging from 1ft. up to 4½ft., with corresponding discharges of 10 and 100 gallons per minute respectively.

THE International Labour Office has been informed that the British Government has taken preliminary steps towards the application of the Draft Convention on the use of white lead in painting, which was adopted by the International Labour Conference last year. The main purposes of the Convention are to prohibit after November 19th, 1927, the use of white lead in the internal painting of buildings, except under agreed conditions, railway stations, and industrial establishments, and, where white lead is not prohibited, to make its use subject to definite precautionary hygienic regulations as from January 1st, 1924, and to make cases of lead poisoning compulsorily notifiable.

IN the course of a discussion on boiler efficiencies at the meeting of the British Association, Mr. C. E. Stromeyer said that it had been found during the war that when oil was used instead of coal in internally-fired boilers, not only was the efficiency reduced, but also the output; in one works he found that, instead of using six boilers, which were sufficient with coal, they had to use seven with oil, for the same output, and the calorific consumption was greater. He believed the reason was that in internally-fired boilers the flame struck the heating surface very soon after the oil was ignited, the flame was put out, and never had a chance of re-igniting. Another source of trouble was the large deposit of black dust in the flues.

IN the course of his presidential address to the Institute of Marine Engineers, Engineer Vice-Admiral Sir George G. Goodwin said that the reciprocating steam engine has reached such a stage of perfection that no radical improvement in its performance is expected, and those to whom it is an acceptable type will take it in its present satisfactory form with the greatest confidence. The steam turbine as a propelling engine is rapidly growing in favour and presents some interesting problems in the practical improvement of its details and in the endeavours to obtain a high thermal efficiency. In the merchant service long running at steady speed, combined with a low fuel consumption at that speed, is essential, and design and experience are concentrated on the fulfilment of those requirements.

WRITING on "Repairs by Electro-plating," in the *American Machinist*, Mr. F. H. Sweet says that in many cases worn parts can be restored to their original dimensions by this method. Nickel is good for this purpose because of its hardness. The part should be thoroughly cleaned and dipped in melted wax. When the film of wax has cooled it is scraped away from the surfaces which require treatment, and the part immersed in the plating bath. As the metal is deposited very slowly it is easy to work to very close limits; yet, if sufficient time be allowed, the deposit may attain a thickness of $^1/_{16}$in. or more. If the operation be properly carried out the nickel adheres to its foundation very tenaciously and is quite continuous and of even thickness throughout. In this way expensive and heavy pieces, such as crank shafts, cylinders and pistons, can be made serviceable again at a cost far smaller than that of a new part. At the other end of the scale very slight wear in delicate machinery, in which close adjustment is essential, may be put right by the deposition of a film of the exact thickness required.

APART from the presence of impurities probably the chief cause of failure of sheet lead and pipes is due to admixture of oxide of lead. The lead in the melting pot is frequently made red hot, and the surface of the lead then oxidises with extreme rapidity and acquires a thick layer of flaky oxide of lead, which is dissolved by the lead near the surface. This lead saturated with oxide finds its way into the mould when sufficient time has not been allowed at a lower temperature for its separation. Although the lead in the mould crystallises out free from the dissolved oxide, each crystal group is enveloped in oxide of lead. On rolling, these crystals cohere very imperfectly and give rise to the brittleness of the lead which is sometimes noticed in the lead boxes that are made to contain sulphuric acid for export. The small quantity of hydrogen evolved by the action of the acid on the lead gives sufficient pressure to form numerous cracks, and the lead becomes so brittle that a slight blow causes it to break. The oxide is often observed when the sheet lead is scraped or cut by a sharp knife.

Miscellanea.

A MEETING was recently held by representatives of the Sheffield foundry trade with the object of organising a trade technical society.

WE regret to learn of the death of Mr. Louis Heathcote Walter, M.A., a member of the staff of the Institution of Electrical Engineers. Mr. Walter had been editor of "Science Abstracts" since 1903.

THE Council of the Concrete Institute has recommended that the title of "The Institution of Structural Engineers" be adopted by the parent body, and that a section of the parent body to deal with concrete and reinforced concrete should immediately be formed with the title of the Concrete Institute. Sections which it is proposed to form include those to deal with concrete, and reinforced concrete, steels, timber, brickwork, masonry, &c.

THE President and Council of the Society of Engineers have issued a circular giving particulars of a conference of engineering societies which they are convening for September 29th next, to be held at the Engineers' Club, London, at 3 p.m., for the purpose of considering and, if thought advisable, inaugurating the formation of an Association of British Engineering Societies. Some twenty-one societies have been invited. The secretary's address is 17, Victoria-street, Westminster, S.W. 1.

A LIQUID Fuel Congress, organised by la Société de Chimie Industrielle, will be held in Paris under the patronage of the Ministers of Commerce, Agriculture, Colonies, Public Works, and Aeronautics, from October 9th to 15th next. It will be divided into the following six sections:—Petroleum, shale, lignite and peat, tar and benzole, alcohol, vegetable oils. Simultaneously there will be an international exhibition of liquid fuels from October 4th to 15th on l'Esplanade des Invalides, divided into two groups—production and utilisation.

RETURNS issued by the Prefecture of the Seine show that during the second three months of the present year the motor omnibuses in Paris travelled 11,134,556 kiloms. and carried 76,311,487 passengers. The receipts amounted to 27,500,136f., which is an average of 2.457f. per vehicle-kilometre. During the night services the omnibuses covered 24,270 kiloms. and carried 52,430 passengers, with receipts amounting to 77,970f., or an average of 3.21f. per vehicle-kilometre. The distance covered by the tramways was 22,706,645 kiloms. and the number of passengers carried 160,871,626. The total receipts amounted to 49,907,909f., representing an average of 2.197f. per car-kilometre.

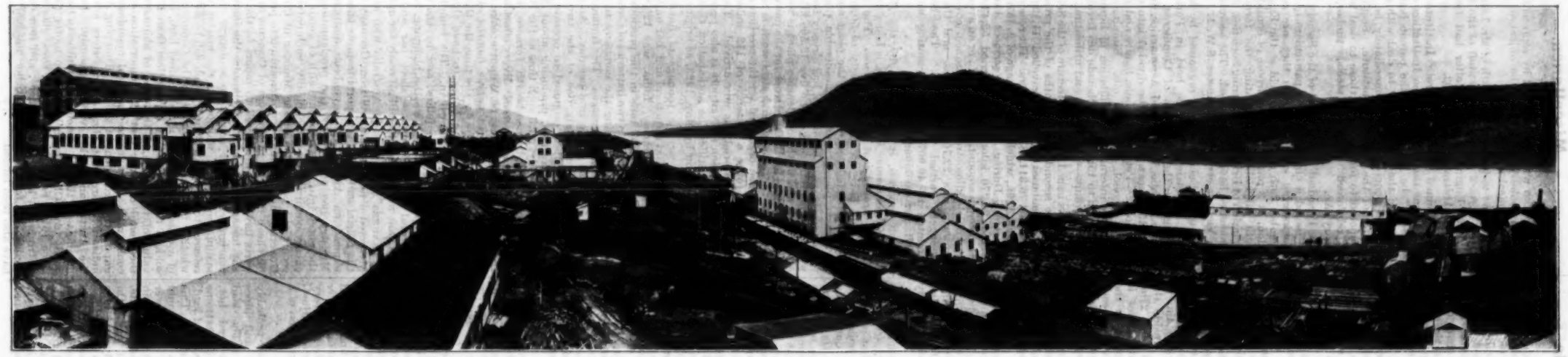
GOOD progress, it is reported by the British Senior Trade Commissioner in Melbourne, is being made with the Morwell brown coal power scheme. The main power-house will have an initial capacity of 50,000 kilowatts. All the principal contracts for the plant and machinery have been placed, and a considerable portion of the transformers, switchgear, &c., has already been delivered, while the manufacture of the five 12,500-kilowatt turbo-alternators and of the condensing plant is well advanced. The contractors for the steel work for the power station are at work on the ground, and steel work is now arriving. Gangs have been organised for the erection of the transmission line (over a distance of 112 miles) for which much of the material has now arrived. The erection of the auxiliary station at Newport is also proceeding satisfactorily, and justifies the anticipation that the station will be in operation by May, 1923, as originally intended.

DURING last year the tonnage of finished products rolled in the rail and structural and bar mills of the Tata Iron and Steel Company, India, was 125,871 tons, as compared with 122,237 tons in the previous year. It is hoped shortly to start up two batteries of the new Wilputte coke ovens, thus enabling the company to blow in one of the large new blast-furnaces. This furnace is estimated to make 500 tons of pig iron per day. An effort is also being made to get ready one of the two open-hearth tilting furnaces. It is proposed to operate this furnace as a stationary furnace, producing about 3000 tons of steel ingots monthly, until such time as the Bessemer converters and second open-hearth furnace are ready to operate on the duplex system. Every effort is being made to get the third battery of Wilputte coke ovens ready for operation in nine to twelve months after the first two batteries are lit, and by the time the third battery is completed the company hopes to have the fifth blast-furnace ready to be blown in. The completion of the various mills will then follow, and by the end of 1923 the company hopes to have the blooming, new rail, and structural mill, continuous sheet bar and billet mill, merchant mill and sheet mill all ready for operation.

TRADERS and others in Australia who anticipated or predicted a flood of imports from Germany immediately the official embargo on imports from ex-enemy countries expired on August 1st have been disappointed. The Ministry has not revoked the proclamation prohibiting the entry into the Commonwealth of goods from former enemy countries, and, technically, such entries must first secure the permission of the Minister of Customs. The Government is taking every precaution to prevent a flood of cheap imports. Collectors of Customs at the various ports have been instructed to report to the Government any instance in which they consider the importation of a consignment would constitute a danger to Australian manufacturers. If warranted, the matter will then be referred to the Tariff Board, which will be asked to decide whether the goods exported to the Commonwealth "are of a class produced or manufactured here, and are being sold to the importer at a price less than a fair market value of the goods at the time of shipment." Should the Board consider that the importation of the goods constitutes a menace to the local manufacturer, it will impose the provisions of the Anti-Dumping Act. Present indications are that German exporters are re-entering the Australian market very cautiously. Items on the manifests of the few vessels which hitherto have unloaded goods from Germany include seven motor cars (the first since 1913), two parcels of dolls, toys, glassware, optical instruments, knitting machinery, and four cases of catalogues. A few pianos and other musical instruments have also been landed.

ELECTROLYTIC ZINC WORKS AT RISDON, TASMANIA

(*For description see page 289*)



PANORAMIC VIEW OF WORKS—OCTOBER, 1921

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By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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TWO-PAGE SUPPLEMENT—GENNEVILLIERS ELECTRIC POWER STATION ON THE SEINE.

DEATH.

On September 19th, at Birchfield, Charlwood, Surrey, MARSHALL BENNETT, husband of Ellen Bennett, age 73. Belize papers please copy.

THE ENGINEER.

SEPTEMBER 22, 1922.

Railway Bridges.

IT is the characteristic of the British Association that, whilst it can soar up and away into the most tenuous atmospheres of contemporary thought, it can with almost equal willingness bring itself down to commonplace affairs. No doubt it is to this versatility that, in no small measure, it owes its attraction. To the general public the daring flights of thought which are found in the special lectures and in the presidential addresses year after year make the greater appeal, owing to the skilful play of the scientific imagination which they permit; but the steady slogging work that is done under the more prosaic portions of the programme is certainly not less valuable if less popular. Consider, for example, the group of papers on railway bridges, of which, with their discussions, we gave abstracts in our issue of last week. It is reasonable to hope that they may mark a turning point in steel bridge construction. Men have gone on building steel bridges with as much regularity as a baker turns out standard buns. Draughtsman after draughtsman has handed down the traditional formulæ—sanctified by various authoritative bodies—and no one has ever effectively inquired if they were really the best that could be evolved. Only now and then in the course of a generation some new bridge, different from any of its predecessors, is built, and even it, in nearly all its parts, is subject to traditional rules and formulæ. It was high time the old school of bridge building thought was shaken up and that the question of the best use of the new materials that the work of metallurgists has put at the disposal of constructional engineers was examined, that the latest views on the strength of structures were tested for their applicability to bridges, and that new methods of construction were investigated.

Yet it is probable that the matter would have escaped attention for another score of years had not the Ministry of Transport declared its intention to impose more drastic rules than its predecessor in the inspection of railways. This intention to modify the Board of Trade regulations arose directly from the work of a committee which carefully investigated the stresses, under given conditions, on a number of bridges. To meet the report made by that committee the Ministry is credited with the intention to make steel railway bridges heavier than ever. After the discussion at Hull we express a hope that the Ministry, if it has indeed any such intention, will hesitate to execute it. The results obtained by the committee are not challenged, but the interpretation of them is clearly open to question, and the adoption of new rules that would still further increase the weight and cost of railway bridges ought to be deferred till no manner of doubt about their necessity remains. In a paper presented at the British Association meeting by Mr. A. C. Cookson and Mr. J. S. Nicholas, of the Great Western Railway, the authors asserted that their own investigations had shown that there was a hitherto unsuspected reserve of strength in nearly all bridge work, and they suggested that the ultimate resistance of built-up members of bridge work should be the subject of inquiry by engineers and research workers in joint action. These experienced men took the view that much secondary work, such as stiffeners to plate girders and overhead bracing to braced structures, was much overdone. Another engineer of equal experience, Mr. Conrad Gribble, of the North-Eastern Railway, expressed his belief that "we were putting far too many rivets into new bridges," and he also urged the desirability of carrying out full-scale tests, making the valuable and practicable suggestion that some of the bridges that have to be removed annually, owing to increasing loads, should be re-assembled and destroyed by static pressure. When we turn to the discussion we find similar opinions expressed. Mr. A. C. Gardner, of the Great Central Railway, declared that there was too much tendency to theorise about bridge design, and that calculations should be regarded merely as an aid to judgment, as there were many indeterminate factors which could only be allowed for as the result of practical experience. Professor F. C. Lea charged engineers with putting more faith in mathematics than the mathematician did and with relying too much on guesswork. He, also, held that it was desirable to conduct large-scale tests of built-up girders, and Mr. Stromeyer expressed the belief that factors of safety were too high, and that too many rows of rivets were employed. Such opinions as these, from men who have direct and, in some cases, daily experience of steel bridge work, cannot be lightly passed by. They may not in themselves be sufficient to overthrow the results of work carried out by such eminent engineers as the late Sir J. B. Ball and Mr. W. A. Fraser, but they do make it imperative that a change in the rules that would make for greater weight and greater cost should be reconsidered before it is imposed, and they suggest that a conference on steel bridge design is overdue.

The impulses—mainly competitive—which drive mechanical engineering continually forward are generally feeble and frequently wholly lacking in such work as bridge design. As a result we find less advantage taken of new materials, a smaller influx of new ideas, and a confirmed tendency to rest content with the proportions, standards and formulæ set up years ago. The ingenuity which was displayed by engineers in the early days of railways is no longer encouraged and no longer displayed. Brunels, Stephensons, Finlays and Telfords are not wanted. Bridges are built to standards because it is cheaper to buy one of recognised design and proportions, because the merits and demerits of the standard designs are known, and because the anxiety which accompanies the employment of new designs is removed. But it is not in that way that progress in engineering is effected. The better is neglected, whilst the worse is employed because its qualities are known and the means of producing it exist. What we have always feared in locomotive design has already occurred in bridge engineering. The search for new types has ceased, and engineers rest content with familiar materials and with familiar rules. The standards satisfy requirements that are lacking in imagination, and no one makes an effort to change them. The symposium of the British Association at Hull is the first indication of revolt; it is a noteworthy fact that the dry bones have only been stirred into life by the alleged intention of the Ministry of Transport to disturb their repose. The alarm will have served a good end if it causes a closer inquiry into the rules and traditions of steel bridge design and gives an opening to those who would seek for improvement by the trial of new materials and new methods.

The Responsibilities of the Stevedore.

IT is customary to read in the newspapers reporting a dock, ship, railway or warehouse fire that the origin is wrapped in the obscurity of its own smoke, or words to that effect. Perhaps this stereotyped official explanation has its inspiration in a desire to prevent blame being cast upon this or that individual, or perchance it is connected with insurance interests. However that may be, very little further information is ever vouchsafed to the public, except on those rare occasions when a Government inquiry is subsequently held. We venture to say that in very many of these cases the

predisposing cause is lack of efficient supervision. From a general utilitarian point of view it seems a pity that the fire inquests of the City of London coroner, and those which are held in New York have no counterpart in our industrial centres. If fire inquests were compulsory much information of a scientific or technical nature would become available and be a lasting aid in the way of combating possible further outbreaks of a similar nature. Although the railway and warehouse have been mentioned, we shall confine our further remarks to shipping in accordance with the spirit of our headline.

With regard to the nature of chemicals, whether they are to be considered as safe or dangerous, the main guide, philosopher and friend of the shipowner and dock authority is the volume entitled "General Railway Classification of Goods by Merchandise Trains." Memoranda relating to the carriage of dangerous goods and explosives in ships are also issued by the Board of Trade when new facts have come to light. Here the question arises as to whether these sources of information are kept sufficiently up to date or whether they could not be amplified to advantage. Discoveries in chemistry proceed apace, and especially during the period of the war chemicals which were formerly sold by the pound for particular purposes came into demand in ton lots. The developments in organic chemistry which have taken place in recent years have brought under the care of transport authorities and workers large quantities of materials new to them. The safe transport of chemicals generally is bound to remain a matter of some risk and complexity, because two substances which may be harmless apart may form a dangerous compound if they come together. With regard to several chemicals the Board of Trade memoranda point out the dangers of propinquity, but it would be futile to expect a very wide field of chemical products to be covered in such instructions. Perhaps we can usefully mention an instance where certain chemicals should not be packed side by side, as we cannot recall ever having seen any reference to it in print. If a certain proportion of liquid carbolic acid is added to bleaching powder or chloride of lime a great rise of temperature takes place, the methane or firedamp evolved taking fire spontaneously. In the case of a serious fire which occurred some years ago on a cargo vessel carrying cabolic acid, bleaching powder and a variety of other chemicals in the same hold there seems very good reason to suppose that a leaky carbolic container was the source of the mischief. Where segregation of certain types of chemicals can be effected on board it is, of course, highly desirable, though obviously the stevedore must be supplied with detailed instructions from the office, where someone with the necessary attainments may possibly be found. The matter of defective drums is one that can properly be left to the stevedore, whose examination ought to take place without hurry before the work of loading begins, though the difficulty here is that it is a common practice to rush goods down to the docks at the last moment. A satisfactory development of late years is the increased use of metal containers in the case of several chemicals, such as chlorate of soda and sulphide of sodium, where the official instructions of the railways or Board of Trade state that either metal drums or paper-lined casks may be used. In a case within our knowledge the stevedore acted with commendable promptitude in removing from the hold of a vessel, which was being loaded in dock, a cask of chlorate of soda which had suddenly burst into flame on the outside. Chemical examination showed that there was chlorate on the outside of the cask and it had undoubtedly become ignited by friction. A great difficulty the shipowner is always up against is the reluctance—perhaps quite natural in the circumstances—of the chemical manufacturer or dealer to admit that there is anything really dangerous about the stuff he is sending for shipment, because such disclosure may mean increased freight rates or port dues. In the bulk of cases, therefore, dock authorities and shipowners will have to continue to look after their own interests. Where the goods are correctly described no great difficulty is presented, especially where such goods have been handled for some time. It is when chemical products are sent under fancy or trade names or otherwise insufficiently described, *i.e.*, as vegetable white or mineral black, or by such a vague title as coal tar salts, that the shipowner feels he is being asked to take an unfair risk. We are not suggesting for a moment that there is any wilful intention to deceive or to submit human lives to definite risks, but we do think that this matter of shipping chemicals insufficiently described is one that merits attention at the hands of the authorities that be.

In speaking of the responsibilities of the stevedore we may have seemed to ignore the fact that the prime responsibility rests with the shipowner, and we hasten to say that shipowners usually show great assiduity in satisfying themselves as to the nature of the goods they accept as cargo; indeed, they frequently decline business because they do not "altogether like the look of it." We note that the Board of Trade recommends that when any doubt exists about the properties of any chemicals not referred to in its memoranda, the case should be submitted to it for consideration. We doubt, however, if this recommendation is frequently carried into effect; the more usual procedure is to turn the business down altogether or to adopt other means of investigation. Without, however, wishing to make the flesh creep, we feel bound to emphasise the fact that no amount of office care can prevent the man at the docks from coming up now and then against cases where some chemical knowledge would be invaluable, especially in connection with carelessness in the packing of goods sent for shipment. For instance, only a few weeks ago there was a serious explosion of a drum of caustic soda owing to the fact that the caustic had been run by mistake into a galvanised iron drum instead of the ordinary sheet iron drum. The explosion was caused by the presence of the hydrogen gas generated by the interaction of the caustic soda and zinc. We have not in mind any case of dereliction of duty induced by apathy or supineness on the part of the officials whose responsibilities we have been discussing. It is their perfectly excusable ignorance of science that seems to us to call for some remedy, especially in view of the categorical statement of the Board of Trade that the various substances referred to in its issued memoranda are not to be considered as forming a full list of dangerous goods. What is desirable is not always expedient, and we do not suggest as a feasible proposition the substitution of the experienced working stevedore, with his ready flow of robust language, by a spectacled scientist. But we do suggest that the material interests involved make it worth while considering whether the ancillary aid of the man of science should not be made more readily accessible to the stevedore than is customary to-day.

The International Railway Conference.

IN a leading article of April 14th, on the eve of the Rome Congress of the International Railway Association, we alluded to the value of the reports to be presented. To-day we draw attention to the equal value of the comments of the speakers who took part in the discussions thereon. The work of the Congress is of supreme importance, because the various reporters and delegates are not only international, but are the highest placed officials, and because they impart information that is denied to any other source, even to fellow railway officers. In the present issue we summarise some of the discussions that took place on questions relating to track, locomotives and rolling stock. It is, for instance, instructive to learn that the French, who have brought the relation between the track and the moving load down to a fine art, are abandoning the staggering of rail joints owing to the oscillation set up. Again, relaying by contract has saved 40 per cent. in Italy. On the Lancashire and Yorkshire all relaying used to be carried out by contract, and it was not only cheaper directly, but very little of it was done by Sunday work, and it was mostly effected between trains, and so saved the cost of single-line working on Sundays. We wondered when we read in Mr. C. J. Brown's report that it had been abandoned, why that course had been taken, but in the discussion the reason was given—the contractors' men would not work at a lower wage than that of the men employed by the companies. The discussion on special steels for rails was very illuminating, and we are not surprised that Section II. expressed a wish that the experiments with manganese steel should be continued—in order to ascertain the best conditions for its use—and that the actual value of other special steels and the best conditions for their use should be determined. As will be noticed when, in a subsequent issue, we summarise the discussion on electric traction, a very wise resolution was arrived at when it was decided that it was very desirable that the methods of keeping and supplying information on this matter should be defined and standardised, and that a committee of the Association should draw up details governing each point, so that in future as full a comparison as possible may be made by figures absolutely comparable. No decision was arrived at as to locomotive cab signals, "because the matter is still in an experimental stage." Thus it will be seen that the Congress, besides affording an opportunity for railway officers of the highest standing to meet and spend a fortnight in each other's company, discusses questions of prime importance and thereby benefits railways the world over.

It is satisfactory to know that the International Railway Congress Association has decided to hold a meeting in London in 1925, to assist in celebrating the centenary of public railway transport. Whatever else may be done by the Government—which ought, in view of the national importance of railways, to take a hand in the commemorations—and the Institute of Transport—which, some months ago, announced its intentions to mark the event—the railways of this country are sure, because they will be, in a sense, the hosts of the Congress, to celebrate the occasion appropriately. Other nations will be interested because many of them, in turn, will soon hold their own centenaries—France in 1928, the United States in 1929, and Germany in 1935. The Railway Congress in 1925 is, we understand, to be of the usual kind, *i.e.*, similar to that in Rome last April, in Berne in 1910, and Washington in 1905. The Permanent Commission is now selecting reporters to deal with the various aspects of interest in track, rolling stock, operation, &c., and their reports will, in due time, appear in the Association's Bulletin and, when the Congress meets, be discussed in the sections.

The International Railway Congress

No. I.

THE August bulletin of the International Railway Congress Association—the name adopted at the recent Rome Congress—contains a summary of the discussions in the sections. These discussions are of value in that they represent the views of others than the reporters, and for that reason we make some abstracts from the bulletin.

CONSTRUCTION OF THE ROAD BED AND OF THE TRACK.

The reports by Mr. E. C. Trench—for Great Britain, India, South Africa, Australia and New Zealand—and Mr. C. H. Ewing—for America—were summarised in THE ENGINEER of March 31st. In the discussion thereon, Mr. Tettelin (Northern of France) mentioned that in 1913 his company used a bed of concrete under a road having four tracks. It had stood up to its work very well, and he had reached the conclusion that, with ground which became mud when wet, a bed of the description solved the difficulty. M. Jullien (Paris-Orleans) pointed out that clay tended to take a sinuous form, with the result that the concrete broke at the hollow places. Instead of the operations described, he preferred to clear the soil away and to make a bed in the form of a saddle, filling the excavation with fine ashes, and on this foundation placing a thick bed of ashes, on which the ballast was laid.

The President (M. Bruneel, Belgian State Railways) of Section I., which considered all the civil engineering papers, asked if the English-speaking delegates would give their experience as to the employment of an intermediate layer of ashes or fine sand. Mr. Trench said that in England it had not been found necessary to use concrete beds; even the most unsuitable clay formations had been successfully dealt with by means of a thorough system of drainage, and by placing under the ballast a suitable layer of ashes or sand. He noted the favourable results which had been obtained in France by means of longitudinal dwarf walls, a method of which he was ignorant. He mentioned, in passing, the advantages obtained in shovel packing for consolidating the sleeper beds. That method originated in England, but had been adopted by the Northern and other French railways.

M. Jullien said that the Paris-Orleans Railway was disposed to adopt the flat-bottomed rail, owing to the simplification of the attachments in point and crossing work. Mr. W. W. Grierson thought that the fastening of the rail to the sleeper by means of spikes was not a good one. The President stated that in Belgium the joints in the rails were both opposite to each other and staggered. M. Jullien thought that staggered joints would have to be abandoned, owing to the oscillation set up. M. Henry (Eastern of France) stated that the French railways had reverted to the practice of giving the rails an inclination of 1 in 20. If laid vertically, there was a tendency to unequal wear at the head of the rail.

Certain conclusions were then submitted to the meeting, which were agreed to, and they were subsequently ratified at the general meeting. Among them are the following:—

> In certain cases where the formation is particularly unstable, a layer of concrete has been laid down under the ballast. Some engineers report favourably on this method of construction; others are doubtful of its value. In any case the cost is exceedingly high.
>
> For flat-bottomed rails the spacing of sleepers

should as a rule be 2ft. 2¼in. between sleepers; for a chaired road 2ft. 7½in. between sleepers.

The minimum weight of rail should be 72 lb. per yard; for more important lines, 92 lb. to 100 lb. per yard. For tunnels, rails of about 110 lb. per yard are recommended.

Some American companies have, on lines of heavy traffic, laid rails of 130 lb. per yard. This practice has allowed them to use high-carbon steels.

MAINTENANCE AND SUPERVISION OF THE TRACK.

The reports of Mr. C. J. Brown—for Great Britain—and Mr. Earl Stimson—for America—were summarised in THE ENGINEER of March 31st. M. Tettelin said that the use of rail motor cars enabled the men, together with their tools and material, quickly to be on the spot where the work had to be done. M. Quinquet (P.L.M.) observed that the P.L.M. motor trolleys were provided with portable telephones which allowed communication with the adjacent station to be made and information given when the trolley had been removed from the rails. Such a gang could look after a section 10 to 12 miles in length. M. Jullien reported that the Blois–Villefranche-sur-Cher secondary line, 33½ miles in length, had been divided into four sections for—? daily—inspection, and into two sections for maintenance. The men used motor trolleys. There were many sidings into which the trolleys could be run. Before a car went out on to the line permission was sought from the next station by telephone. The organisation worked very well, and had resulted in an economy of 1400f. per kilometre per annum.

Mr. Guiseppi Barbieri (Italian State Railways)—reporter for all countries except Great Britain and America—took part in the discussion, and said that since 1908 the Italian State Railways had entrusted the repairs of 1243 miles of railway to a private company. The results had been very satisfactory. Since the Armistice they had let by contract general repair work. Good results had been obtained, especially in Northern Italy. The relaying of 115 miles on the Padua section had resulted in an economy of 40 per cent. After a couple of trials with mechanical apparatus for boring and packing sleepers, satisfactory results had been obtained. It was possible to pack from 95 to 100 sleepers per hour, an economy of 25 per cent. being obtained as compared with similar work carried out by the ordinary method. The tendency of the Italian State Railways was to have the work of general relaying carried out by co-operative contract. The people employed were old casual servants of the railway. The State found the necessary material, distributed it along the line, and took charge of the spent and scrap material recovered from the track. The Italian State was seeking to obtain the best result by interesting the worker by means of bonuses. Mr. W. H. Coomber (London and North-Western) said that the opinion prevailing on English railways was that relaying and repairs could not be satisfactorily carried out by contract. In fact, contrary to the opinion expressed in Mr. Stimson's report (America), men employed by contractors would not work at a lower wage than men engaged directly by the railway companies.

The President said that at the St. Petersburg Congress, 1892, it was proposed to reduce the inspection of the line—? by the ganger—to one visit per day. It was also proposed to do away with gatemen at the less important level crossings. These recommendations had been put into force in Belgium since the Armistice, and had resulted in an economy of more than a million francs in inspection and 3½ million francs by dispensing with certain gatemen. The latter had not resulted in any untoward incident, and now seemed to be well established.

Mr. C. J. Brown thought that the better distribution of the men, especially by the increase in the length of the section, and the utilisation of motor cars, ought to be considered. The road was only inspected once a day in England. On the less important crossings on branch lines—? light railways—no gatemen were provided; but cattle guards were furnished. Mr. Barbieri (Italian State Railways) said they had 17,000 level crossings, certain of which were not guarded before the war. The introduction of the eight-hour day led to a Royal decree being promulgated authorising gatemen to be dispensed with at all level crossings which were sufficiently visible from the road and the rail. That will finally result in gatemen being withdrawn from 6000 level crossings. Warning boards are to be erected instead. Experiments were being made with a view to providing automatic signals—? electric crossing bells actuated by approaching trains—at the more important level crossings or where those crossings were not sufficiently visible—? where the road vehicle driver has not a sufficient view of the line—in order to do away with gatemen at these points. The number of inspections had been reduced to a minimum of one per day on less important lines. These economies had resulted in a saving of 30 millions—? lira.

Among the conclusions agreed to were the following:

The attention of engineers in charge of maintenance of track should be directed to close supervision and systematic control of the work of the maintenance staff, and to such reorganisation, wherever possible, as would enable advantageous use to be made of mechanical appliances, with a view to greater efficiency and economy.

One of such methods of reorganisation is to group together at a convenient centre a number of small gangs into one large gang, equipped with means of rapid transport, thereby permitting better supervision, greater efficiency of labour and consequent reduction in the total number of men required.

The employment of contractors for the maintenance of the track is not favoured by all companies. That method may or may not be advantageous, according to local circumstances.

Inspection of the track should not be made more than once daily, and, under certain circumstances, may be reduced or even dispensed with.

Where legislation permits, reducing or even abolishing level crossing keepers offers further possibilities of effecting considerable economy.

SPECIAL STEELS.

The report of Mr. W. C. Cushing (Pennsylvania system)—for America—was summarised in THE ENGINEER of March 31st. The President of the section said it was proposed to limit the discussion to particular points without entering into the details of the manufacture of the special steels. He asked the delegates representing English-speaking countries to give information on four points, of which two were:—(1) Has the introduction of manganese steel caused the use of spring crossings to be abandoned? (2) Is the price in England for manganese steel three times in excess of that for ordinary steel? In France the price is only double.

Mr. Arthur R. Cooper said that the Metropolitan District and the London Electric Railways always used spring crossings. For about twenty years they had employed manganese steel, and had obtained very favourable results and a great economy compared with ordinary steel. The general life of track equipment made in manganese steel was from six to ten times as long as that obtained from ordinary steel. He was only able to give pre-war figures as to cost. Manganese steel cost £27 per ton, as compared with £7 per ton for ordinary steel. In order to give an idea of the great durability of manganese steel rails, he stated that at places where ordinary steel rails were worn out in twelve months, his company substituted manganese steel rails five years ago. They were still in service, and it was hoped they would last another five years. On very sharp curves—those of, say, 5 chains radius—rails had been scrapped owing to their being corrugated and not from loss of weight. The Sandberg sorbitic steel rails used on the District which had otherwise given satisfactory results, had been taken out of service for the same reason. The advantage of sorbitic steel should be from 80 to 90 per cent., but it was reduced to 40 per cent. since they had to be withdrawn owing to corrugation. He had obtained excellent results from manganese equipment cast in one piece, but chiefly on points where the speed was low. His experience was that built-up apparatus was better where the speed was great.

M. Schrafl (Swiss Federal Railways) said he had had crossings of manganese steel cast in one piece on trial since 1910 at points where the traffic was dense, and they had given very good results. Moreover, it was not yet possible to determine, even approximately, their future life. They had one grave defect—as the manganese steel could not be drilled, it was necessary to have special fish-plates closely fixed to keep the crossings in position, and if one of these fish-plates broke it was difficult to replace it as quickly as necessary. His company had also fitted manganese steel plates to the wing rail of a certain number of crossings, at the point where the tire passes over the wing rail. Ten of these placed in position in 1912 were perfectly intact to-day, and some were in positions where ordinary crossings would be worn to the same extent in three months.

Mr. C. P. Sandberg (Siamese Government Railways) said that in all cases where points and crossings had only a life of four or five years, he strongly recommended the employment of manganese steel. The use of Sandberg sorbitic steel for crossings would give results very superior to those attained with ordinary steel, as that material offered much greater resistance to wear and crushing. Since Mr. Cushing wrote his report—THE ENGINEER, March 31st—the results obtained on the Turkey Hill curve on the Pennsylvania had been published by Mr. Shand, the chief engineer, who had kindly given the complete results to the speaker, and allowed him to quote them. They showed that rails of Sandberg sorbitic steel had increased the life by 85 per cent., whilst the extra cost was only 12 per cent. above ordinary steel. These experiments covered a period of two years, and were carried out on rails weighing 130 lb. per yard, rolled by the Bethlehem Steel Company from steel having 0.7 per cent. of carbon. The Boston Elevated Railway had found that Sandberg rails gave a life twice that of ordinary carbon steel rails. About fifty railway companies in different parts of the world were making experiments with rails and tires manufactured by the Sandberg process. As the sorbitic microstructure was combined with more ductility in the main body of the rail, it was an ideal material for such purposes. The use of higher carbon content steel, or increasing the weight of the rails, was a less favourable means of solving the problem. Springs, which ought to have the highest possible elastic limit to resist shock, ought also to be treated so as to give a sorbitic structure. Without a great increase in weight, one was able to have rails with a sorbitic structure, which allowed them to acquire much greater resistance to wear and crushing than was the case with ordinary steel rails.

The conclusions of the section were:—

Cast manganese steel with 12 per cent. of manganese and 1.3 per cent. of carbon gives excellent results, and is economical for use in crossings. It is especially so in crossings cast in one piece. It is also advantageous for rails on curves of small radii in cases where the traffic is dense and speed low.

Opinion is not unanimous with regard to the use of other special steels. The superiority of any one of them is not universally acknowledged.

Tempering rails is favoured by a few engineers; the majority are against that practice, except in cases where a sorbitic structure is desired.

It is desirable that experiments be continued to ascertain what are the best conditions for the use of manganese steel, and to determine the actual value of other special steels and the best conditions for their use, as well as to determine the causes of the failures of rails in service.

REINFORCED CONCRETE.

Mr. W. W. Grierson's report—for Great Britain—was summarised in THE ENGINEER of April 7th. The author opened the discussion in the section, and laid special emphasis on the fact that one ought to be extremely careful in the construction of reinforced concrete, as it was often found that the results of laboratory experiments were carried out under different conditions from those which pertained on the work itself. He also expressed doubt as to the durability of concrete work, and he thought that the effect of impact on reinforced concrete constructions was not thoroughly understood. M. Mesnager (French Ministry of Public Works), who, by the way, received the congratulations of the President and many others on the way in which he organised the discussion on "Special Steels," did not agree with the doubts Mr. Grierson had thrown upon direct tests. Such tests ought to be reliable, if carried out in the shops or even on the works, as under those conditions the experiments should be sufficiently trustworthy to give confidence in the results. The official regulations kept impact in mind, and he did not know of a failure of reinforced concrete when the calculations had been properly made in accordance with those regulations. M. Séjourné (P.L.M.) spoke of his experience with a tunnel on the Nice–Coni line, where "Ciment Fondu" alone had resisted the action of water containing sulphates, all other cements having given bad results. The actual experience with this material had now extended over five or six years, and should be sufficiently conclusive. This material, M. Mesnager explained at the request of the President, had a composition high in aluminates, and acquired in about three days a strength equal to that which ordinary cement reached in six weeks. It continued to harden, and so gave two important advantages:—(1) The possibility of removing the shuttering after a very short time, and (2) the possibility of reducing, by about one-half, the dimensions of the concrete members. Its cost was double that of ordinary cement, but, nevertheless, a very considerable economy resulted, partly, in the carrying out of work with a limited quantity of shuttering. Mr. F. Lolli (Italian State Railways) stated that his company had since 1900 constructed more than 500 bridges in reinforced concrete. They were of from 6½ft. to 62ft. span, and up to the present were standing well.

Among the conclusions arrived at by the section were the following:—

For many works reinforced concrete is often a more economical material than masonry or steel, particularly for bridges, footbridges, water tanks, buildings, workshops, locomotive sheds, goods warehouses, and verandah roofs for passenger and goods platforms.

The drawings should be carefully prepared, particularly the details of the joints of the bars, which should be shown in such a manner as readily to make clear what was intended. Works in reinforced concrete required constant supervision on the site by competent technical men, who had had the necessary practical experience.

When properly designed and with suitable material, the cost of maintenance of reinforced concrete was sometimes almost negligible; more often than not, it was less than that of masonry or brickwork, and considerably less than that of steel work.

For railway bridges, which were subject to dynamic forces, there appeared to be no technical reason against the use of reinforced concrete which could frequently be used advantageously, but required very close supervision in its execution. It was always advantageous to lay a bed of ballast or an elastic layer of wood between the track and the concrete, and it was necessary that the surface of the superstructure should be maintained in a thoroughly water-tight condition.

Scientific and Industrial Research.

No. II.*

IN last week's issue we reprinted in full the annual report of the Committee of the Privy Council for Scientific and Industrial Research. In what follows we give a summary of the principal portions of engineering and kindred interest in the report presented to the Committee by its Advisory Council.

The Council's report opens with a detailed statement of the efforts made to secure economy of expenditure in accordance with the Government's request for all-round reduction. The financial aspect of the Committee's work was sufficiently set forth in last week's issue to render further consideration here unnecessary. It may be remarked, however, that expenditure on the National Physical Laboratory, the Fuel Research Board, the Geological Survey, and the Food Investigation Board is regarded by the Council as well-invested money, and cannot be reduced below the already diminished amounts without imperilling the very existence of the departments. Grants to research workers and students are defended as essential on the ground that they offer the principal means of developing and securing the services of an adequate number of research workers of high scientific attainment. The remaining heads under which the Department incurs expenditure are regarded as less immediately vital to our means of life than those just named. It is not clear whether among such less vital activities the Council includes its assistance towards the establishment of research associations. The sum of money spent in this direction is, of course, derived from a grant of a million pounds made in 1916, and is not subject to an annual vote.

Research Associations.—Twenty-two out of twenty-four research associations licensed by the Board of Trade are in active operation. Of these twenty-two, two are now in their fifth year, four in their fourth, nine in their third and seven in their second. The grants made from the million pound fund to research associations are limited to five years. The Council therefore issues a mild note of warning to the more elderly associations to the effect that at the end of their fifth year they will be expected to be completely supported by the industry or industries which they serve. The report sets forth a few of the benefits which have already accrued from the work of the research associations. Specific instances are quoted in connection with the manufacture of Portland cement, scientific instruments, cotton and linen. The report dwells with gratification upon the co-operation in the matter of research now being shown, not only between different members of the same research association, but also between one association and another whose interests in some respects may overlap. The most flourishing association at the present moment would appear to be that connected with the cotton industry. This association has an annual income of about £20,000, and is supported by more than 90 per cent. of the firms in the industry. It has established its research headquarters at the Shirley Institute, a large mansion house standing in 14½ acres of freehold land. The Council attaches much importance to the holding of conferences between representatives of the different research associations, and during the year organised one in which nineteen associations took part. It is again emphasised that the associations exist primarily for the purpose of undertaking fundamental research, and not for the removal by investigation of immediate and practical difficulties. There is little basic difference, it is held, between industrial and pure scientific research, except in the source from which the stimulus to its conduct is received. The outlook, the spirit and the methods are the same. Some associations have successfully coped with problems of specialised application, and as a result have gained the confidence and trust of their members at a time when such confidence and trust were much desired. Such work, however, should not be regarded otherwise than as a secondary function of a research association. The report illustrates this matter by a reference to the work of the Food Investigation Board. From the first this body concentrated its attention on the general investigation of the fundamental physiology of living and dead foodstuffs. Recently its attention was called to a large loss of apples from Australia, as the result of the development of "brown-heart." From the general investigations previously made, the Board was able almost at once to trace the trouble to the carbonic acid gas generated by the apples themselves during the voyage, and to prescribe the necessary remedy.

The Co-ordinating Research Boards.—The work of the boards established to co-ordinate the scientific investigations of the various Government Departments has made steady progress in the direction of securing close co-operation between the Departments. As an instance, it is recorded that the Acoustical Research Establishment of the War Office is now conducting experiments for all three Services, all of which contribute towards the cost. The Department of Scientific and Industrial Research also assists the work financially to an extent representing the degree to which it is of general scientific interest, and can be made generally available. Much attention is now being paid to co-operation between research associations and the Service research work undertaken under the guidance of the co-ordinating boards, although the confidential nature of the work on both sides sometimes makes it difficult for information to be passed from one side to the other. Under the auspices of the Physics Co-ordinating Research Board reports are to be published dealing with the results of the Admiralty's investigations at St. Margaret's Bay into the determination of the velocity of sound in water and the determination of a ship's position by radio-acoustic means. Similarly, the experiments at Shandon on leader gear, completed during the year, are to be fully described in a report now being prepared. The Chemistry Co-ordinating Research Board has dealt with various important matters affecting Government Departments, such as the production of formaldehyde and of high-grade zinc sulphide for luminous paint, the cause of the explosion at Oppau, Germany, and the improvement of accumulators. Under the Engineering Co-ordinating Research Board work has been begun on an investigation of the design of big-end bearings for high-speed internal combustion engines. The design of laminated and spiral springs, the suspension of motor vehicles, the fatigue of materials, the production of brass strip ingots, and the possible commercial uses of the minor metals occurring in the British Empire, have also received the Board's attention or financial assistance.

The Radio Research Board.—The Radio Research Board has been in existence for three years, and is continuing to do highly important and valuable work. Its new station at Aldershot has now been completely equipped, and at it researches are in progress on the fundamental nature of atmospherics. It is hoped that the results obtained will lead to that very difficult, but highly important problem, the elimination of atmospherics, being attacked on sound lines. Very satisfactory progress has been made by the Directional Sub-committee. Observations on the variation of errors of bearing of fixed stations have been continued, and the results are being analysed and prepared for publication. Reports are also in preparation on a comparison between various systems of direction finding, and on the effect of local conditions as regards the production of errors. Experiments on land and sea are now being conducted to determine the influence of the configuration of the transmitting aerial and the aerial circuits on the observed errors in bearing. The Thermionic Valve Sub-committee has been studying the fundamental physics of its subject, and the general physical problem involved in the production of a metal transmitting valve.

Oxygen Research Committee.—The work of this Committee has been conducted in co-operation with the Oxygen Section of the Air Ministry's Research Department. Many mechanical improvements in containers and vaporisers for liquid air and oxygen have been made, among which is a triple-walled vaporiser without heating coils. The evacuation plant referred to in the previous report has proved very successful, and has surpassed anticipations in the saving which it effects.

Gas Cylinders Research Committee.—The Committee is now studying those gases which are commonly stored and transported in the liquid state, and the possibility of using alloy steels for the manufacture of gas cylinders. Arrangements have been made with the British Engineering Standards Association for the standardisation of cylinder fittings.

National Physical Laboratory.—Except as regards routine test work, the Laboratory has not been much affected by the prevailing trade depression. There has, in fact, been an actual increase in the special research work undertaken on behalf of research associations, the co-ordinating boards and private firms. Advantage has been taken of the diminution in the volume of work carried out at the National Tank for private shipbuilding firms to push on with the programme of general research approved by the Tank Advisory Committee. A similar remark applies to the Aerodynamics Department, which, with the completion of a large duplex wind channel, has made much progress in the study of air screws and of the lateral stability of aeroplanes. With the completion of the third storey of the metallurgical building, a research into pure metals is about to be begun. In conjunction with the Iron and Steel Institute, the Metallurgical Department is now preparing and issuing on demand samples of chemically standardised steel.

* No. I. appeared September 15th.

ELECTRIC DEVELOPMENT IN VICTORIA.

THE following particulars relating to the progress of electrification work in Victoria have been forwarded to the Department of Overseas Trade by H.M. Senior Trade Commissioner in Australia in continuation of the report issued by the Department in April last. The scheme was described in some detail in the last report, but it may be repeated that the whole of the works are being carried out by the State Electricity Commission of Victoria. The scheme has been previously referred to as the Morwell brown coal scheme. The main power-house is to be situated at the new township of Yallourn, about 5 miles from Morwell, and is expected to be in operation in about two years' time. It will have an initial capacity of 50,000 kilowatts, and will contain five 12,500 k.w. turbo-generators.

Excellent progress is being made with the extensive works involved in the complete scheme. All the principal contracts for the plant and machinery for the main power station at Yallourn have been placed, and the reports indicate that the progress with the manufacture of the machinery is good. A considerable portion of the transformers, switchgear, &c., has already been delivered, while the manufacture of the five large turbo-alternators and of the condensing plant, which is being made by Thompson and Co., of Castlemaine, Victoria, is well advanced. The greater part of the preparatory work on the site has been completed. The contractors for the steel work for the power station are at work on the ground, and steel work is now arriving. Gangs have been organised for the erection of the transmission line—over a distance of 112 miles—for which much of the material has now arrived.

The erection of the auxiliary station at Newport is proceeding satisfactorily and justifies the anticipation that the station will be in operation by May, 1923, as originally intended. In connection with the coal-winning operations, the removal of the overburden has already commenced, and it is expected that the winning of coal will be begun by the end of this year. A considerable portion of the briquetting machinery is now arriving. Much work has been done at the site in preparing foundations for the plant and machinery which is expected to be operating by the end of 1923.

The Government has authorised the erection of a model township at Yallourn, the site of the works, and this scheme is being put in hand with all speed. The township, which is estimated to cost £224,000, will provide, in its first stages, accommodation for the Commission's employees in 200 tenements, but the final scheme makes provision for a population of 3000.

INDIA'S IMPORT TRADE.

IN a note dealing with India's import trade during April, May and June, H.M. Senior Trade Commissioner at Calcutta says that it is not surprising that the prodigious imports of machinery and mill work of last year have not been maintained. The total imports in the first quarter fell from 10 to 6.4 crores. The British share was reduced from 8 to 5¼ crores, and that of America from 1¾ to half a crore, but German imports increased from 9 to 19 lakhs. Although German shipments are increasing, the only serious competition in machinery at the present time is that from the United States, and it is observed with some satisfaction that the imports from America have declined to a very much greater extent than those from the United Kingdom. In the case of electrical machinery, the British share increased from 71 to 74 lakhs in contrast with a decline in American imports from 36 to 12¾ lakhs. The imports of railway plant and rolling stock for the three months were reduced from 6¼ to 4¼ crores. Of the latter figure the United Kingdom supplied no less than 4.06 crores. The remaining imports consisted mainly of non-competing lines, such as wooden sleepers, &c. In spite of the depression in trade and the considerably increased import duty, the total number of cars imported advanced from 630 to 894, the respective values being 45.7 and 35 lakhs. It is noteworthy that while the number of British cars fell from 155 to 75, the American imports increased from 176 to 405, and those from Canada from 105 to 301. British, French, and Italian cars have all been seriously affected, and it is extremely probable that this is owing to the fact that they are the better grade and higher-priced vehicles which cannot stand an import duty of 30 per cent. in competition with cheap American and Canadian cars. The figures largely go to show that the increased duty is, in effect, giving a preference to the American type of vehicles. The number of motor omnibuses, vans, and lorries advanced from 144 to 148, but as their value declined from 11 to 7.8 lakhs, it may be assumed that they were mainly of cheaper American types. There was a reduction in the number of motor cycles imported from 185 to 148. The British share of these declined from 121 to 110, that of America from 34 to 26, and that of other countries from 30 to 12. The total imports of coal during the quarter amounted to no less than 333,000 tons as compared with 171,000 tons in the corresponding period of last year. The United Kingdom contributed 203,000, Natal 71,000, Portuguese East Africa 25,000, and Japan 21,000 tons in the period under review.

The Sila Hydro-Electric Project.

THE growing industrial demands for power in the south of Italy point to the utilisation of some of the larger water powers, and a very important financial group, Società Meridionale di Elettricità, initiated by Comm. Maurizio Capuano, the Chairman of the Sila Company, working in conjunction with the Banca Commerciale Italiana and with the Società delle Strade Ferrate Medridionali and other financial houses in which Vickers, Limited, are interested, is now promoting a scheme for the supply of electricity to Puglia, in Southern Italy, and of water for irrigation purposes to the important districts around and north of Cotrone. The Pugliese Electric Company will transmit the power *viâ* Taranto in Puglia, to the provinces of Lecce and Bari. It is proposed eventually to supply energy to Sicily.

The River Neto affords excellent opportunities for hydro-electric development, and it is proposed to obtain from it a total of 168,267 horse power, whilst water for irrigation purposes will be supplied to the agricultural land on the lower reaches of the river, thus bringing into irrigation an area of about 24,700 acres. The project entails the harnessing of the upper water of the Neto, and its two important tributaries—the Arvo and the Ampollino—by the construction of storage reservoirs on these rivers, and the leading of the regulating discharges to power houses situated lower down the valley, as shown on the accompanying plan and cross-section.

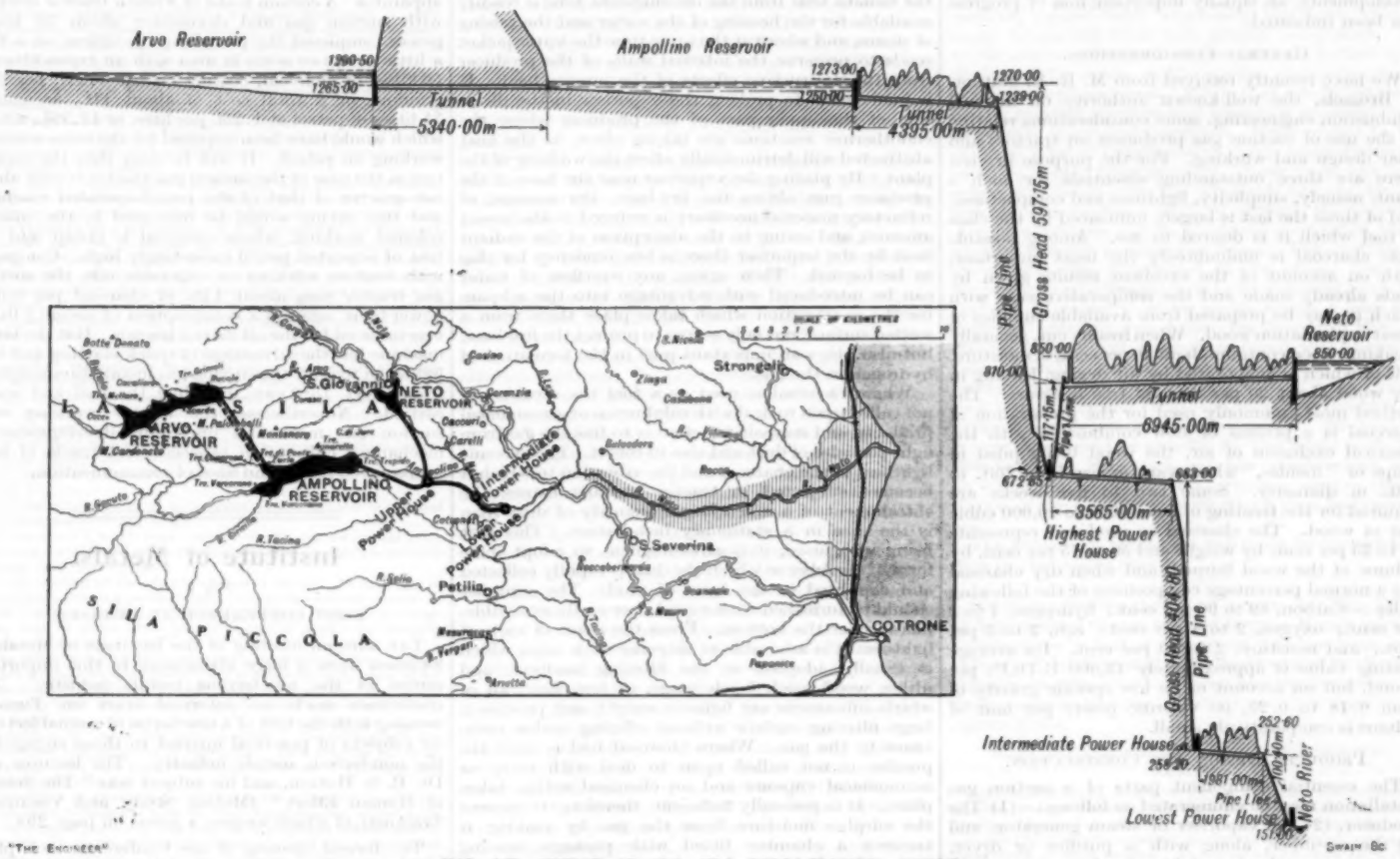
The reservoir on the river Arvo will have a top water level of 1287 m.—4223ft.—above sea-level. The masonry dam impounding the water will be built across the stream close to the village of Nocella. The dam will be about 40 m.—some 130ft.—high and about 270 m.—some 900ft.—in length, whilst the reservoir capacity will

be about 157,000,000 cubic metres, say, 34,540,000,000 gallons. The stored water from this reservoir will be led through a tunnel of 5340 m.—about 3¼ miles—in length to the Ampollino reservoir. The latter will be formed by constructing a masonry dam 31 m.—say, 102ft.—high, and 138 m.—just over 450ft.—long across the Ampollino River close to Trepido. The top water level of the reservoir will be 1270 m.—4176ft.—above sea level, and the capacity impounded will be 61,000,000 cubic metres—13,420,000,000 gallons. The total capacity of these two reservoirs, 218,000,000 cubic metres—47,960,000,000 gallons—will form the main storage of the proposed scheme, and will yield 6.5 cubic metres per second—or 85,800 gallons per minute—as a continuous discharge.

Taking off at an altitude of 1250 m. above sea level from the Ampollino dam, a tunnel will be constructed through the hillside to a point directly over the proposed upper power station, the length of the tunnel being about 4395 m. At the outlet end of the tunnel will be constructed a surge tank, and a pressure forebay for the pipe line. The power station will be built close to the river Neto, where a gross head of 597 m.—1958ft. 9in.—will be available. The upper reaches of the river Neto will be tapped by means of a small reservoir formed below S. Giovanni, by building a dam 62 m.—just over 200ft.—high and 190 m.—623ft.—in length across the river, thus impounding about 17,000,000 cubic metres—3,740,000,000 gallons. The reservoir will not be large enough wholly to regulate the flow in the river, but its regulating action, combined with the natural flow, will yield 8.5 cubic metres per second—say, 112,200 gallons per minute—as a continuous discharge. A tunnel 6945 m. in length will lead from the reservoir and will emerge opposite the proposed power station already mentioned. The whole of the machinery will be concentrated here, that portion of it deriving its water from the Neto working under a gross head of 117 m.—say, 384ft.

Owing to the favourable configuration of the ground, it will be possible to utilise the tail waters from this upper power station to the extent of 15 cubic metres per second—198,000 gallons per minute—by constructing a canal and tunnel of 3565 m. in length, to a point further down the river, where a gross head of 404 m. will be available. It is proposed to construct here a second intermediate power station, where 80,960 horse power will be developed. By a further development lower down the river, again utilising the tail water from the intermediate station, a third power station can be constructed capable of yielding 20,080 horse power under a head of 100 m.

The project is one which can be developed in stages, according to the industrial requirements for power, and the well-known Italian hydro-electric engineer, Signor Angelo Omodeo, of Milan, who has prepared the scheme, has kept this very important point in view when making his proposals.



MAP AND SECTION OF THE SILA HYDRO-ELECTRIC SCHEME

THE electrical attraction effect studied by the Danish engineers, Messrs. Knud Rahbek and Alfred Johnsen, and described by them before the Institution of Electrical Engineers in May, 1921, has many possible applications, some of them being of considerable practical interest. From a recent article in the *Elektrotechnische Zeitschrift* it is evident that these applications are being exploited on the Continent, and the matter is one with which British engineers should keep in touch.

Patents Extended.

IT is important to inventors, particularly if they are patentees, to note what patents are extended by Order of the Court beyond their normal term. First, because if patents are extended, new patents may infringe the basic patent; and, secondly, because the considerations which come into question are likely to apply in their own case should they in due course have to apply for a prolongation on their own grant. Such matters as the particular way in which the accounts are kept, information of all profits and losses incurred, which have to be dealt with in special ways during the whole life of the patent, may well be overlooked until too late unless one realises from decided cases what is essential.

Two patents have recently been extended for inventions relating to fire and temperature alarms or indicators. The application for extension was made independently of loss due to hostilities, although it was pleaded that the patentee had been hindered in exploiting the patents by the war. It was contended that the merit of the inventions was such that an extension should be granted.

The object of the invention protected by the earlier patent was to render the mechanical multiple-element type of fire alarm reliable by providing a continuous wire with loops held in form by fusible metal wholly supported by the wire member in tension. The subject matter of the later patent was a special construction of fusible member practically comprising a central brass ring, brass end cheeks and fusible member, cementing the whole together, the wire being wound round the hub of the alarm and gripped between the side cheeks or flanges.

Evidence was given that the petitioners' device was very simple in construction, less expensive to install and maintain, and was more reliable than any previous system. The difficulty that arose in placing the invention successfully on the market was that the patentee could not obtain the certificate of the Fire Offices Committee without which fire insurance rebates could not have been secured, so that for the major part of the life of the patent it was impracticable to install the system.

The inventor himself gave evidence in court, and explained to the learned judge that the only occasion in which he had known the apparatus to fail in the sense that it permitted an alarm to be given without an actual fire was one in which a series of the thermostatic elements was mounted on a stretched wire just below the glass roof of a building through which the rays of the sun at the height of summer were passing, the temperature, in fact, being raised to the same point, namely, 160 deg. Fah., that if caused by a fire would release the apparatus. When the thermostats are heated to this temperature the fusible alloy melts, the side flanges and central hub have therefore nothing to maintain them together so that the twist of the wire, together with the action of the weight keeping it in tension, forces these elements apart, the length of the wire being thereby extended by a matter of a number of inches whereupon the weight falls and an alarm is given.

It was admitted that the invention was meritorious, and it was sought to show that it was a class of invention which could reasonably be included in the term "exceptional cases" in which event the Court would have had power to extend the term of grant by a period amounting to ten years. Practically all the cases which have been so extended up to the present time for the long period, that is, more than five years under the new Act, and more than seven years under the older Acts, are those in which exceptional merit was shown. In this particular case the Crown did not oppose the grant of an extension of five years, but did object to a longer extension, and after hearing the whole of the evidence Mr. Justice Sargant granted an extension of five years from the date of the expiry of the first patent, so that the two patents will now run until 1927.

In 1906 the Austin Motor Company obtained a patent relating to the lubrication of the bearings of multi-cylinder engines, according to which the engine case is divided into two or more compartments, each of which is formed to drain towards the centre. The drainage is carried to an oil receiver by inclined tubes, which terminate above the level of oil in the receiver to prevent oil from running back into the casing. The oil is circulated by a set of three rotary pumps, the middle one of which draws oil from the sump and delivers it to the shaft bearings. The outer pumps drain oil from the casing compartments and have together a greater capacity than the centre pump in order to ensure a thorough and rapid drainage of the casing. This patent, No. 15,866 of 1906, being dated July 13th, would normally have expired this year, but an application was made to the Court under the modern procedure by way of originating summons for an extension of the term of the grant owing to loss incurred due to hostilities. The applicants alleged that throughout the war, having been engaged in the manufacture of munitions, they had not been able to produce any motor cars, and, indeed, that the effective output of cars had not begun until 1920. For this reason they suffered damage in that they could not utilise the patent as they otherwise would have done. Applicants were exclusive users of the invention, and were using it extensively before the outbreak of the war. They applied for an extension for the whole period of the war, four years and three months, first apparently in error having asked for an extension of ten years. The Crown did not object to the shorter period asked for, so that after hearing the petition the learned judge came to the conclusion he would grant an extension of the patent for four years and three months from the date of expiry. The patent not having lapsed at the date of extension no special limitation of the terms of grant was made.

IMPROVEMENT OF MONTREAL HARBOUR.

THE Montreal Harbour Commission is making rapid headway with its plans to increase the facilities of the port. Among the new works already sanctioned is a grain elevator, which will have an initial capacity of 2,000,000 bushels, but will be capable of being extended to 8,000,000 bushels. The first cost is 2,347,000 dols. This expansion of the grain-handling facilities has been rendered necessary chiefly by reason of the large volume of American grain passing through the port. The high-level quay walls will be extended at a cost of approximately 475,000 dols., and the extension to existing piers will require about 1,500,000 dols. Other improvements will cost 500,000 dols. One of the most important features of the new harbour plans is in connection with the building of a new bridge to the south shore of the St. Lawrence, for which a preliminary appropriation has been made. The bridge is expected to cost 10,000,000 dols.

THE Swedish Waterfall Board has prepared plans for the construction of power stations on the rivers Fjällsjöälven and Nämforsen in North Sweden aggregating 72,000 horse-power.

The Suction Gas Tractor.

The success of the recent trials of suction gas vehicles in France, described in our issue of September 1st, has undoubtedly caused renewed interest in the problem of the application of the suction gas producer to the agricultural tractor. Although any saving either in the cost of land tillage or transportation which might result from successful suction gas working would certainly be welcomed by the home farmer and tend to extend the use of such mechanical aids, the larger field for development along these lines is to be found in the Colonies. This is particularly true of such countries as France and Belgium, in whose colonial possessions of Morocco, the Soudan and the Belgian Congo there are large tracts of land where mechanical transport and tillage are rendered prohibitive in cost by the high price of imported petrol. For some years past experiments have been made with engines using native vegetable oils, and some degree of success has already been achieved in this direction; but in view of the latest suction gas developments, an equally important line of progress has been indicated.

General Considerations.

We have recently received from M. R. E. Mathot, of Brussels, the well-known authority on internal combustion engineering, some considerations relating to the use of suction gas producers on tractors and their design and working. For the purpose in view there are three outstanding essentials for such a plant, namely, simplicity, lightness and compactness, and of these the last is largely influenced by the class of fuel which it is desired to use. Among possible fuels charcoal is undoubtedly the most important, both on account of the excellent results given by trials already made and the comparative ease with which it may be prepared from available supplies of forest or plantation wood. When freshly cut, generally speaking, wood contains about 40 per cent. of moisture, half of which is evaporated by air drying, leaving in dry wood about 20 per cent. of free moisture. The method most commonly used for the preparation of charcoal is a process of slow combustion with the practical exclusion of air, the wood being piled in heaps or "meules," which vary in size from 26ft. to 49ft. in diameter. Some two to five weeks are required for the treating of from 5000 to 10,000 cubic feet of wood. The charcoal so produced represents 20 to 25 per cent. by weight and 50 to 75 per cent. by volume of the wood burned, and when dry charcoal has a normal percentage composition of the following order:—Carbon, 89 to 90 per cent.; hydrogen, 1 to 2 per cent.; oxygen, 2 to 4 per cent.; ash, 2 to 5 per cent.; and moisture, 2 to 10 per cent. Its average heating value is approximately 13,500 B.Th.U. per pound, but on account of its low specific gravity of from 0.18 to 0.25, its calorific power per unit of volume is comparatively small.

Producer Design and Construction.

The essential component parts of a suction gas installation may be enumerated as follows:—(1) The producer, (2) the vaporiser or steam generator, and (3) the scrubber, along with a purifier or dryer. Having in view the desirability of reducing the weight and the size of the plant to the smallest *practical* limit, the use of cast iron should be reduced as far as possible and preference be given to a thin sheet metal construction in which riveting may be well replaced by welding. The weight of a suction gas producer designed for tractor service should not exceed from 13 lb. to 17 lb. per horse-power. Dealing with the producer itself, the only parts where cast iron is called for are the doors of the fire-grate and ashpit and parts of the mechanism for feeding the fuel to the producer from the containing hopper. In designing this part of the apparatus care should be taken to avoid any arrangement of mechanism which tends to crush the very friable fuel. With a view to reducing weight the zone of refractory lining material should be as small as possible, both as regards thickness and size, and in some cases it may be advantageous to replace the refractory material with an alternative form of construction in which cast iron water-cooled walls are used. The water jacket may then serve as a vaporiser for producing the required steam.

The quality of the gas produced varies greatly according to whether the producer is worked at a high temperature or a low temperature. In the former case—"hot working"—a producer using anthracite coal requires a grate area of about 0.05 square feet per horse-power, whereas for "cold working" a grate area of from 0.16 to 0.21 square feet per horse-power will be found necessary. Reducing, therefore, the grate to the smallest area consistent with the use of charcoal fuel, and assuming that the producer will be worked "hot," a figure of from 0.06 to 0.08 square feet per horse-power as the grate area is reached. Apart from considerations of size, hot working is more economical, because the temperature maintained in the producer permits of reactions taking place which allow of the maximum dissociation of the combined water, with a corresponding increase in the hydrogen content of the gas. On the other hand, hot working tends to a more rapid deterioration of the producer walls, particularly at the incandescent zone. If, on the contrary, the producer be worked cold, a gas poorer in quality, but more stable in composition, is obtained, and the walls are less liable to attack, but the size of the producer is correspondingly larger.

At the present time most producers work with a closed hearth, but the open-hearth producer possesses the great advantage that attention may be given to the fire and clinker removed from the grate without disturbing the generation of gas. It is to be hoped that before long a satisfactory form of small portable producer embodying this feature of design will be introduced. The vaporiser calls for careful design if sedimentation and scaling difficulties are to be successfully overcome. With the use of waters which contain heavy sediments, unless care is taken, heavy incrustations soon appear, with a consequent loss of evaporative efficiency and tendency to serious cracking. Vaporisers of the form containing nests of tubes easily accessible for clearing are to be recommended. From the point of view of simplicity and lightness it is preferable that the design adopted should be one which permits of the vaporiser being incorporated in the body of the producer. A convenient position is the base of the producer, where the radiant heat from the incandescent zone is readily available for the heating of the water and the raising of steam, and where at the same time the water jacket tends to preserve the internal walls of the producer from the destructive effects of the intense heat. It is inadvisable to prolong the vaporiser in the direction of the upper part of the producer where the endothermic reactions are taking place, as the heat abstracted will detrimentally affect the working of the plant. By placing the vaporiser near the base of the producer just above the fire-bars, the amount of refractory material necessary is reduced to the lowest amount, and owing to the absorption of the radiant heat by the vaporiser there is less tendency for slag to be formed. Then again, any overflow of water can be introduced with advantage into the ashpan, for the evaporation which takes place there from a wetted surface, not only serves to protect the fire-bars, but also plays an important part in the formation of hydrogen in the gas.

Where charcoal is used as a fuel the scrubber is not called upon to deal with sulphurous or ammoniacal products, and its main function is to free the gas from light particles of dust and also to cool it. The extreme lightness of the charcoal and the vibration to which it becomes subjected in tractor working causes the entrainment of a much larger quantity of dust than is the case in a stationary installation. This fact being recognised, it is advantageous to adopt some form of scrubber in which the dust is rapidly collected and deposited in the form of mud. The scrubber should be furnished with a mud door easily accessible, placed near the bottom. From the point of view of lightness it is advisable to dispense with coke, which is usually adopted as the filtering medium, and utilise wood wool, birch twigs, or horsehair, all of which substances are light in weight and provide a large filtering surface without offering undue resistance to the gas. Where charcoal fuel is used the purifier is not called upon to deal with tarry or ammoniacal vapours and no chemical action takes place. It is generally sufficient, therefore, to remove the surplus moisture from the gas by making it traverse a chamber fitted with passages, causing repeated and abrupt changes in its direction of flow. In order to control the working of the producer it is advisable to install a simple U tube water gauge both between the producer and the scrubber and the scrubber and the dryer. This tube enables any disturbance in normal working, such as a settling of the fire, a stoppage in the ash discharge, or an obstruction in the filter or connecting pipes, to be easily discovered. When the producer is running under full-load conditions the syphon should not indicate more than from 4in. to 6in. water gauge pressure.

The amount of water required for the producer varies from 50 to 75 per cent. of the weight of fuel used, and, in addition, water is further required for the washer and for gas cooling. In fixed installations this generally amounts to between two or three gallons of water per horse-power per hour, but such a figure is quite impossible for tractor working, and some method of cooling the circulating water is required. Perhaps the best method is by means of a radiator and fan, as commonly used in automobile practice. This method certainly avoids the losses associated with open type coolers, which may amount in hot climates to 5 and 10 per cent. With regard to the pipe arrangement in general, the absence of corrosive products of distillation permits of the employment of steel tubes, but adequate cleaning facilities should be provided.

The Type of Motor and Results.

The type of motor which gives the best results for tractor work is the four-stroke cycle ordinary automobile motor having either two or four cylinders. The two-stroke cycle motor is not, on account of its cycle, so readily adapted for working on gas of low calorific power. Taking into consideration the robustness in design which is indispensable for tractor work, it is well not to exceed an engine speed of from 800 to 1000 revolutions per minute. For suction gas working a power rating from 15 to 20 per cent. less than that adopted for petrol working should always be employed. This more liberal rating is necessary on account of the low calorific power of the gas, which averages from 160 to 180 B.Th.U. per cubic foot, its normal chemical composition being represented by the following figures:—Hydrogen, 15 per cent.; carbon monoxide, 25 per cent.; carbon dioxide, 10 per cent.; nitrogen, 50 per cent. The comparatively low hydrogen content of the gas permits of the use of higher compressions than those which are used in petrol engines, and for suction gas a compression pressure of from 140 lb. to 170 lb. per square inch may be taken as a representative figure. The engine should be so designed as to give the maximum access to parts, enabling cleaning and examination to be readily made. This applies particularly to the water jackets, valves and pistons. The resistance offered to the spark is considerably higher for suction gas mixtures compressed to the aforementioned pressures than in the case of a petrol-air mixture, and for tractor work it is essential that high-tension magnetos should be employed.

The results given by tractors which have been fitted with a suction gas installation working on charcoal fuel are certainly very promising, and some progress has been made in the perfecting of the apparatus A certain make of French tractor working with suction gas and developing about 35 horse-power completed the ploughing operations on a field a little over two acres in area with an expenditure of 50 kilos. of charcoal, costing on site 0.22f. per kilogramme, or a total cost of about 11f., as against 35 litres of petrol at 1.25f. per litre, or 43.75f., a total which would have been required for the same machine working on petrol. It will be seen that the cost of fuel in the case of the suction gas tractor is only about one-quarter of that of the petrol-operated machine, and this saving would be increased in the case of colonial working, where charcoal is cheap and the cost of imported petrol exceedingly high. Compared with tractors working on vegetable oils, the suction gas tractor uses about 1 lb. of charcoal per horse-power hour, against a consumption of about ½ lb. of vegetable oil for the oil-driven tractor. But the latter machine has the advantage of quick starting and it is lighter in weight, the suction gas installation weighing from 6 cwt. to 9 cwt., including the fuel and water carried. Nevertheless, the tractor working with suction gas marks an important development in mechanical cultivation, especially for tracts of land far removed from main lines of communication.

Institute of Metals.

No. I.

First Conference at Swansea.

The autumn meeting of the Institute of Metals in Swansea drew a large attendance to this important centre of the non-ferrous metals industry. The conference made an informal start on Tuesday evening with the first of a new series of annual lectures on subjects of practical interest to those engaged in the non-ferrous metals industry. The lecturer was Dr. R. S. Hutton, and his subject was "The Science of Human Effort" (Motion Study and Vocational Training), of which we give a *précis* on page 298.

The formal opening of the Conference took place on the morning of September 20th in the Llewellyn Hall, Swansea.

The Mayor, Alderman W. Owen, said that those engaged in the non-ferrous metals industry of the Swansea district joined with the civic representatives in welcoming to the town the members of an institute whose work was so closely related to the industrial activities of Swansea. The smelting trade of the district began at Neath about 300 years ago, and was established at Swansea in the year 1717. At a later date the famous Vivian family commenced operations. The choice of Swansea as the centre of the industries with which its name was now associated arose from the existence of the local coalfield, which assured supplies of cheap fuel for metallurgical operations, so that it seemed a preferable policy to import ores into Swansea rather than carry fuel to the ore. By slow process of development, Swansea had become the greatest metallurgical centre in the world. The scientific side of the non-ferrous metals industry had not been neglected, and the system of education adopted had been designed to further the developments of the trades that had done so much for the town. The latest and, of course, the most important development was the University College. It was a tribute to the recognition by those engaged on the industrial side to the need of scientific research that the manufacturers of the district had provided 50 per cent. of the capital outlay of £100,000 on the University, and had agreed to make annual contributions of £5500.

Dr. T. Franklyn Sibly (Principal of the University College) associated himself with the welcome accorded by the Mayor. It was, he said, a very gratifying feature that those responsible for the policy of the city and for the development of its industries had taken so prominent a part in the establishment of the University.

Mr. Leonard Sumner (President of the Institute) said that it had been desired for a long time past to hold a Conference in Swansea, which was a great centre for the production of the metals in which the

Institute was interested. The virtues and defects of Swansea had long been recognised. Dr. Percy, writing of Swansea in the year 1861, after pointing out the eligibility of Swansea as a smelting centre, because it had an excellent port easily accessible for ships bringing ores into the district, said: "Swansea smelters enjoy the privilege of pouring dense volumes of thick sulphurous and arsenical smoke from comparatively low chimneys into the atmosphere, destroying the vegetation for a considerable distance around." That privilege had now become a right which would not be conceded in any other part of the kingdom. The inhabitants of Swansea generally seemed to be habituated to the inhalation of that smoke, and submit to the evil, if evil it was, with unmurmuring resignation.

The reading and discussion of papers was then proceeded with.

The sixth report to the Corrosion Research Committee by Dr. Guy D. Bengough and Mr. J. M. Stuart was briefly presented by the first-named.

SIXTH REPORT OF THE CORROSION RESEARCH COMMITTEE.

This report attempts to present a general discussion of corrosion phenomena, based on the study of several different metals, and to examine how far the electro-chemical theory of corrosion—usually called the electrolytic theory—can account for the observed phenomena. The difficulties encountered by this theory are indicated, and it is shown that it gives a satisfactory account of the facts only under certain conditions, while many facts can only be explained by recognising the important part played by colloids in corrosion. A theory of the mechanism of colloid action is put forward, and some experimental results are reviewed in the light of this theory.

The report commences by defining the terms corrosion, chemical exfoliation, erosion and scale, which are used somewhat loosely by some writers. Corrosion is defined in its widest sense as the oxidation of a substance. It is then pointed out that such oxidation may be produced by chemical or electro-chemical means, and these two types of reaction are defined. Chemical reactions may occur when the reacting bodies are in contact; electro-chemical reactions when the reacting bodies are spatially separated. In the latter case the reacting substances must be capable of ionisation, and a portion of the energy of the system appears as electrical energy. Two cases of corrosion are considered, both of which can be carried out chemically or electro-chemically. Pure electro-chemical action may in certain cases be relatively unimportant. Thus the cathode of a cell of high voltage may be more rapidly attacked than the anode, while an anode at a high voltage tending to force it into solution may be very little corroded, owing to scale formation.

Further facts which are difficult to explain on a purely electro-chemical theory are the following:—

(1) Certain depolarisers do not increase corrosion, but actually inhibit it.

(2) The conductivity of electrolytes is not directly connected with the amount of corrosion.

(3) Lambert's pure iron—probably the purest metal ever produced—was found to be readily attacked by sodium chloride solution and dilute acids.

(4) According to the electro-chemical theory, the presence of ions of the corroding metal should depress the corrosion of most of the common metals. There are, however, numerous exceptions, and in some cases the presence of such ions actually increases corrosion.

The order of corrodibility of metals in distilled water, certain salt solutions, and non-electrolytes is different from their order in the electro-chemical list, which suggests that there are factors interfering with the electro-chemical action. Such a factor is scale formation, and a main factor in determining the amount of corrosion by water and salt solutions is the nature and distribution of the products of corrosion. This may be far more important than any hypothetical distribution of cathodes and anodes in the metal.

The effects of strain and impurity in the metal are considered on the electro-chemical view to be of fundamental importance, and Lambert's pure iron and lead were prepared with a view to eliminating both these factors. Neither metal was incorrodible in certain conditions. However, potential differences between strained and unstrained portions of the same metal are usually very small, and unstrained (annealed) metal may corrode more rapidly than strained metal. In fact, the effect of strain is a minor and ephemeral factor in corrosion in neutral solutions.

As regards the effect of impurities on the corrosion of metals, a trace of impurity appears to assist local corrosion, but the amount of corrosion is not proportional to the amount of impurity. Even the presence of graphite does not appreciably stimulate the rate of corrosion of iron. The effect of a trace of impurity is probably a trigger action.

Local action at metallic surfaces may be produced in a variety of ways at any selected points by modifying the conditions external to the surfaces, and is not mainly determined by the presence of anodic areas on the metal. Minute pores in a metal may, however, give rise to local action, as has been shown by Seligman and Williams.

On the electro-chemical theory the action of oxygen is that of a depolariser. It can be shown, however, that atmospheric oxygen has very little depolarising power at ordinary temperatures. The main function of oxygen in corrosion is to oxidise directly the metal, and also in some cases the products of corrosion.

The effect of over-voltage on corrosion phenomena is briefly considered.

Two chief types of corrosion are distinguished: (1) The general type, usually characteristic of acid corrosion; (2) the local type, usually characteristic of corrosion in water and salt solutions. The second type is generally characterised by the formation of an adherent scale on the metal, and this scale may contain colloid.

A theory is developed regarding the part played by colloids in corrosion, and this theory may be briefly outlined as follows:—

A metal immersed in water sends positively charged metal ions into the liquid, and becomes itself negatively charged. In the case of ordinary commercial metals the metal also becomes superficially oxidised if dissolved oxygen is present. The hydroxide produced by this oxidation can take up the ions given off by the metal, and the hydroxide thereby passes into the state of a positively charged colloid. Some of this colloid will diffuse away, permitting further reaction between the oxygen and the metal surface, and thereby reforming the hydroxide film over the latter. Oxidation is then stopped till this hydroxide can pass into the colloidal state by acquiring positively charged metal ions. This, in general, does not take place till the colloid initially formed has diffused into the presence of electrolyte, when it is precipitated by the anion of the dissolved salt, the caution neutralising the charge on the metal corresponding to that on the colloid. This allows the metal to send more ions into solution, and the uncharged hydroxide thereby acquires a charge. If the colloid so produced can diffuse away, the process can continue and corrosion develop.

For steady corrosion, therefore, the colloid must be produced under conditions which allow it to diffuse some distance from the metal before precipitation. If it precipitates directly on the corroding surface it will, in general, adhere to the latter and stop corrosion. In the case of a corrosion pit the first condition is fulfilled, since no precipitation occurs inside the pit. It is only when the colloid diffuses through an aperture—generally very small—in the gel-deposits at the mouth of the pit, that it meets electrolyte and is then precipitated. Such precipitation merely thickens the external gel-deposits. These gel-deposits adhere directly to and protect the metal surrounding the pit, and thereby emphasise the local nature of the corrosion.

Professor H. C. H. Carpenter said that since the work of the Committee was inaugurated to investigate the problem of the causes of corrosion of marine condenser tubes, the work had been enlarged. The first three reports to the Committee dealt mainly with the corrosion of condenser tubes, and it was not until the fourth report that an indication was given that it was necessary to go outside this particular study and to investigate the fundamental causes of corrosion. The last publication in connection with the work was a pamphlet which presented in a compact form the investigation which had been made up to that time. The present report was of a more general character, but the Committee and those engaged in the work had been much encouraged in the increase in the donations made by the Brass and Copper Trades' Association. The main topic of the present report was the nature of corrosive action and the function of colloids in corrosion. The investigators had been forced to get down to the root question as to what corrosion was. The function of colloids was a new aspect of the subject, and it was probable that the report was the most important contribution which had been made to the "Transactions" of the Institute.

Mr. U. R. Evans expressed satisfaction that the authors of the report laid stress on the physical character of the corrosion product in determining the persistence of corrosion. It was noteworthy that those metals which, like iron or nickel, had oxides soluble in acid and insoluble in alkali, tended to become active in the presence of acid and passive in the presence of alkali. Metals like tungsten or molybdenum, which had oxides soluble in alkali, but almost insoluble in acid, tended to become passive in an acid solution, but were rendered active in an alkaline solution. In considering the behaviour of the more reactive metals towards different aqueous reagents, one was tempted to say that the insolubility of the hydroxide was the main determining factor. The only metals quickly attacked by pure water were those, like sodium and potassium, which had soluble hydroxides, whereas metals, like zinc and aluminium with hydroxides soluble in alkali, were quickly attacked by caustic alkali, although other equally oxidisable metals, like magnesium, were scarcely attacked at all. Turning to the question of whether corrosion was chemical or electro-chemical, it would appear that since the atoms were certainly electrically charged in the combined state, corrosion was essentially a passage from the uncharged to the charged condition, and consequently an electrical factor must be involved. In that sense, even the so-called "direct chemical attack" was really electrical. The type of electro-chemical corrosion which was associated with the production of distinct anodic and cathodic areas was, however, another matter, and it was a question still requiring experimental investigation how far that electro-chemical type was responsible for known corrosion phenomena. The difference between that electro-chemical corrosion and direct chemical corrosion was that in the direct chemical type the metal would only be attacked at those points to which the oxidising agent, usually dissolved oxygen, had direct access; in the electro-chemical type corrosion might occur at places to which the oxidising agent had no access. There was another line of argument which lead in a logical manner to the conclusion that much of the corrosion met with in practice, and which the authors attributed mainly to chemical action, was to a great extent of the electro-chemical type. The different behaviour of the different metals was dictated by the solubility and physical character of the corrosion product. The dissolution of metals in acid was much more rapid than in neutral solution, and accorded rather better with the position of the metals in the potential series. He would like to refer to a complicating factor, *i.e.*, the remarkable super-saturation phenomenon which was known to electro-chemists as over-voltage. Pure zinc was hardly ever attacked by acids, owing to its high over-voltage, but certain impurities, and especially metals which were more noble than zinc and which had low over-voltage values, had a remarkable accelerating action on corrosion. Of course, they could only act as cathodic areas when present as a separate phase. If uniformly distributed in solid solution, they had no immediate influence. But all the noble impurities in zinc, whether present in solid solution or between the grains, appeared as a black scum on the surface of the metal as attack proceeded. That fact gave an explanation of the so-called period of induction observed in the corrosion of zinc. When zinc was first immersed in acid the attack was slow, but as the black scum, consisting mainly of lead and cadmium, appeared on the surface, dissolution proceeded faster and faster. It was found by Centnerszwer and Sachs that if the black scum was removed, the rate of attack dropped again, a fresh period of induction being afterwards observed. It would seem therefore that the difficulties raised by the authors of the report largely disappeared when the matter was closely investigated.

Mr. W. H. J. Vernon said that, speaking as one who had defended the principles of the electrolytic theory, he was glad to note that the present report, while it placed limitations upon the scope of that theory, gave it a bigger place in the sun than had been accorded to it in the fourth report of the Committee. He still thought that the fourth report was rather too speculative in its findings, but he agreed that in the case of a metal immersed in the liquid in which the concentration of displaceable ions was relatively low and whose content of dissolved oxygen was relatively high, the conception of direct oxidation as advocated in the fourth report provided a reasonable explanation of the initiation of corrosion over at any rate a very wide range. That that was not the whole of the story, however, was evidenced by the fact that oxidation in such a liquid usually proceeded considerably faster than in exposure to air where the oxygen concentration was so much higher. The theory advanced in the present report filled in the breach with a very ingenious explanation, which deserved most careful attention. It was interesting to note that the authors incorporated electrolytic phenomena as well as direct oxidation into their explanation of the initial action. He did not propose to discuss that theory, but would content himself with expressing the hope that it might ultimately meet with general acceptance. He would like to refer back to the galvanic surface type of electrolytic action, and to emphasise its importance in corrosion phenomena. While that action naturally had its greatest effect in acid liquids, it occurred quite frequently in neutral solutions. With regard to the external type of couple action, very many examples could be quoted from practice. Some years ago legal action was taken over the wholesale damage done to iron ships in Leghorn Harbour through the presence of copper bottom yachts, electrical connection being afforded through hawsers and buoys. The electrolytic theory was then vindicated to the extent that the copper-bottomed vessels had to be removed from the harbour. Coming to more recent times, a case was described only last year before the American Electro-chemical Society of a schooner cased with plates of monel metal. Contact of that metal with the steel rudder frame and other exposed steel parts caused such rapid corrosion that the ship was broken up without having made a single voyage. All workers in corrosion would be grateful for this latest contribution from Dr. Bengough and his collaborators, and he would like to express his own very sincere appreciation of the invaluable work which they had carried out.

The authors of the report will reply by correspondence to the points raised.

Sir Henry Fowler then read a note on "The Effect of Superheated Steam on Non-ferrous Metals used in Locomotives" and a paper on "Grain Size and Diffusion" by Professor J. H. Andrew and Mr. Robert Higgins was presented. There was no discussion on these communications, of which we give brief summaries below.

SUPERHEATED STEAM AND NON-FERROUS METALS.

Superheated steam is now very generally used on locomotives, the steam usually leaving the superheater at a temperature of 340 deg. Cent. Not all the parts mentioned are continuously subjected to this temperature, as the steam expands and in so doing falls in temperature. The practice referred to is that adopted on the Midland Railway.

Piston Tail Rod Bushes.—These were originally made of M.R.A. 1 alloy of the following composition:—Copper, 87 per cent.; tin, 9 per cent.; zinc, 2 per cent.; lead, 2 per cent. This material was found to break in service. The cast iron which replaced it scored the rods, but a phosphor-bronze of the following composition has proved satisfactory:—Copper, 88 per cent.; tin, 11 per cent.; phosphorus, 1 per cent.

Piston-rod Packing.—McNamee rings of the following composition:—Copper, 75.5 per cent.; tin, 8.5 per cent.; zinc, 0.33 per cent.; phosphorus, trace; nickel, 0.5 per cent.; lead, 15 per cent., are used satisfactorily. These rings prevent the steam coming into contact with the white metal packing rings, of the following composition:—Lead, 70 per cent.; antimony, 30 per cent. Recently, when the temperature of the steam leaving the superheater has been as high as 425 deg. Cent., trouble has been caused by the packing rings fusing. The full heat falls intermittently only on these parts.

Piston valve fittings and cylinder relief valves made of alloy M.R.A. 1 have proved satisfactory.

By-pass valves are subjected to shock, and good quality cast iron, gun-metal of M.R.A. 1 alloy, and phosphor-bronze, as tried in tail rod bushes, are unsatisfactory. Parts made of complex nickel-brass, however, gave good service, but in view of the expense were replaced by malleable iron or steel castings.

GRAIN SIZE AND DIFFUSION.

Experiments have been conducted which show the relation between grain growth and diffusion. Diffusion at high temperatures may take place simultaneously with grain growth, whilst at low temperatures diffusion promotes a breakdown in the grain size. These results are applied to the annealing treatment of commercial castings, and a suggestion is advanced to explain the atomic arrangement existing at the grain boundary. It is assumed that in the interior of the crystalline grains the system of closest packing holds, whilst at the boundaries the atoms in the separate grains touch only at one part of the circumference. This hypothesis explains the decrease in specific gravity with an increase in the number of grains, for in such an arrangement certain free spaces must occur. Plastic deformation, by shifting the atoms in certain grains from their position of equilibrium, will cause these atoms to rearrange themselves when heated to a sufficiently high temperature; this rearrangement will be so brought about that the stressed atoms will fall in with, row for row, the unstrained atoms of the adjacent crystal, thereby effecting a gradual migration of the grain boundary. Such a rearrangement may proceed from every side of a crystalline unit, resulting in one grain being divided up and being absorbed by others. The final bounding surface will result when a state consistent with that suggested for the boundary configuration finally results. A suggestion based upon the Langmuir idea of valency is given to explain the migration of a separating phase to the grain boundary.

THE CHERNIKEEFF ELECTRIC SUBMERGED LOG

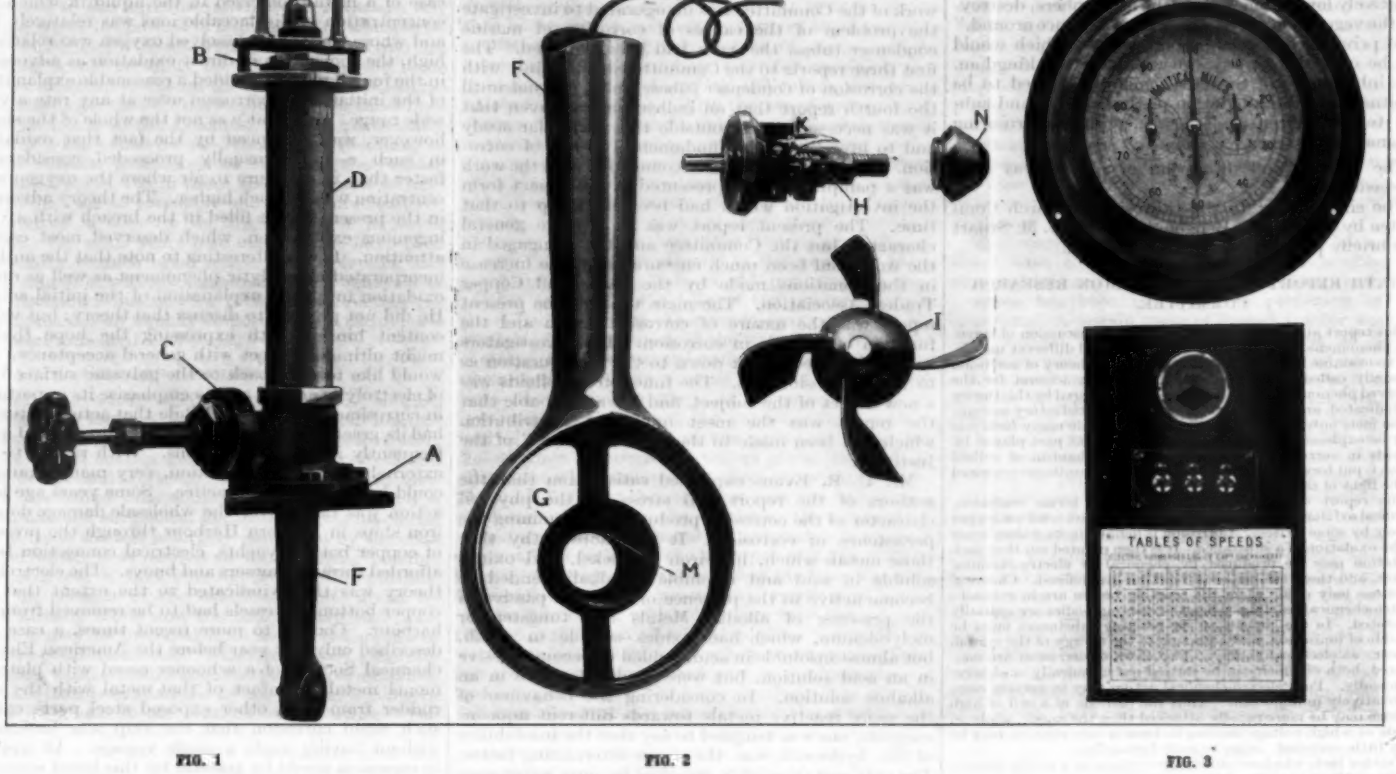


FIG. 1 FIG. 2 FIG. 3

The Chernikeeff Electric Submerged Log.

THE safe and successful navigation of a vessel between two points is an operation which is directly dependent on the accuracy with which three essential measurements of time, direction, and distance are made. Although the instruments for making the first two of these determinations, namely, the chronometer and the compass, long ago reached the standard of scientific instruments of proved accuracy, it must be admitted that the ship's log, which is used for the measurement of distance, has not attained, until very recent years, the same degree of precision. The old-fashioned log, which was towed from the ship's quarter, has certainly given place to newer forms, some of which operate mechanically by means of a vaned screw and others again on the hydraulic principle, some form of Pitot tube being employed. Experiments made with these improved forms of ship's log have certainly affirmed the desirability of fixing the log at some determined point on the hull of the ship where it is totally submerged and at the same time is free from wave and propeller disturbance. In using the mechanical log, however, it has been found that the friction caused by the packings round the shaft of the rotating element invariably introduces a certain variable element of resistance, which tends to render the reading of the log inaccurate, especially at slow speeds. The hydraulic log, too, possesses the same defect, and it is generally complicated in its construction owing to the necessity of having to introduce some form of mechanical device between the hydraulic system and the recording instrument.

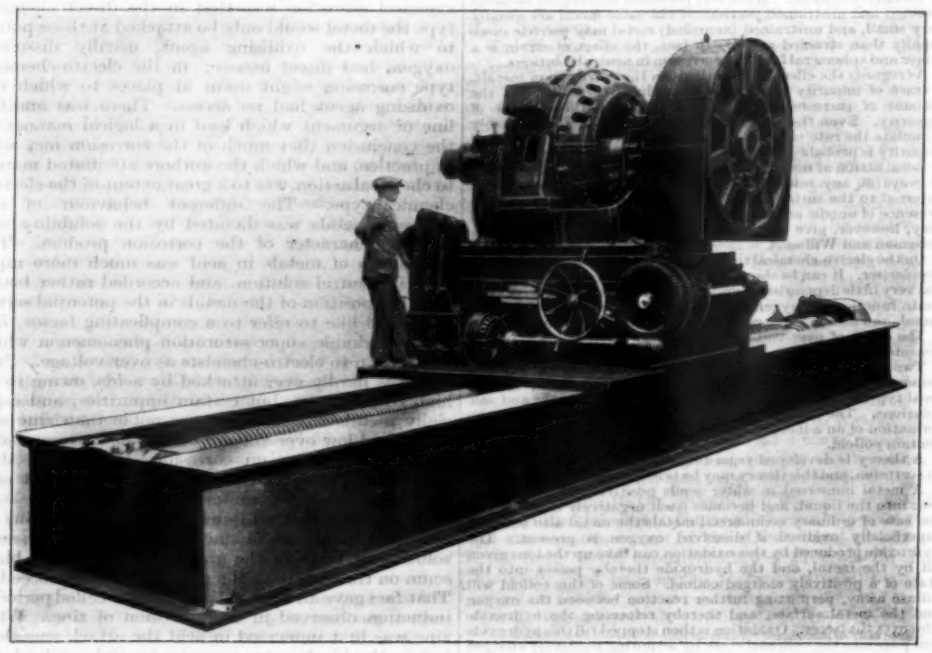
The new electric submerged log described in this article was invented by Captain Chernikeeff, the late Chief Hydrographer of the Royal Russian Navy at Sebastopol, and is now manufactured by the Electric Submerged Log Company, of 33 and 35, Eastcheap, London. This log would seem to mark a distinct advance both in design and construction, and it is claimed that its readings are accurate at the lowest speeds and over wide ranges of speed, and that it is readily accessible for inspection or repair, and may be calibrated at any time. The views reproduced show the general arrangement of the log and the recording apparatus and some details of construction. Referring to Fig. 1, the log itself will be seen to consist of two main parts, one internal to the ship's skin, and one external and submerged. In the view given the ship's skin is indicated by a piece of plate to which the flange A is bolted. Attached to this flange is a sluice valve C, which in turn carries the main connecting tube D, which at its extremity is fitted with a stuffing-box and gland unit B. This tube also carries a flange which serves to locate the position of the handle casting E carrying the nut and connecting cable. The part of the log exterior to the ship's hull consists of an Admiralty gun-metal supporting arm F, which carries the rotating element and through which the insulated electric cable passes. Fig. 2 shows this part in detail. The supporting arm is provided at its extremity with an annular conical seating G, which carries the main bearing and shaft H on which the vaned screw I is fixed, and from which it drives by means of double-worm and worm gears the commutator or make-and-break disc K. An insulated spring transmits the impulse to a terminal stud M placed in the bearing seating, to which the insulated cable is connected. The rotating elements are completely submerged in oil, the space surrounding them being filled with lubricant and sealed by the screwing on of the tail nut N, whilst a number of grooves turned on the shaft effectively prevent the water from gaining access to the working parts. The mechanism operates with very little friction, the thrust of the screw being taken by a single thrust ball bearing.

In Fig. 3 we show the recording instrument, the dial of which is calibrated to indicate distances in one-twentieth of a mile up to 10,000 miles. The indicator is so arranged that the index may be turned to zero at will. The small switch panel is provided with a voltmeter to test the voltage of the dry battery supplying the necessary current, and with three switches which are used (1) for connecting the voltmeter to the terminals of the battery for testing; (2) putting the recording instrument in circuit; (3) connecting in circuit a buzzer which gives an audible signal for every twentieth of a mile traversed, so that with the aid of a stop watch the actual speed of the vessel at any moment can be determined. The voltmeter and buzzer switches are only intended for intermittent use. The electrical energy for operating the system is provided by a 6-volt battery of dry cells having a capacity sufficient for a 50,000 miles run.

The log is capable of being fitted to any ship without docking, a special boring tool being used to make the necessary connection to the ship's skin. It will also be appreciated that by means of the sluice valve provided the log can be removed for inspection at any time and its accuracy may be checked by fixing it to a boat and towing it between two measured points marked on the ship's side.

A Large Armour Plate Grinding Machine.

THE large armour plate grinding machine illustrated herewith—said to be the largest appliance of its kind in the world—has recently been constructed to the order of the Japanese Government by Tasker's Engineering Company, Limited, of Sheffield. Since Messrs. Tasker started making plant of this description over twenty years ago, the size of the machines produced has progressively increased. In the first machine made by the firm, the main motor in the headstock was of about 20 horse-power; in the machine illustrated it is of 120 horse-power. The total weight in the present instance is about 60 tons. The grinding disc, of the inserted segment type, is 44in. in diameter, and from the floor to the top of the disc measures 11ft. 9in. The body of the machine is 6ft. 6in. wide, and has an overall length of 36ft. It will thus be seen that the machine is unusually large for an appliance



ARMOUR PLATE GRINDING MACHINE FOR JAPAN

of its class. It will be understood, of course, that in our engraving the table whereon the armour plate is supported during the grinding process is not shown. Further, the grinding disc is illustrated without its stone segments. The actual grinding operation is performed on the edges of the armour plates, and is effected by the faces of the stone insertions.

The bed of the machine is a one-piece casting, and is formed with wide planed and scraped bearing surfaces, provided with oil recesses and rollers. It is stiffened by means of cross stays, whereto are fitted gun-metal bearings for carrying the main driving screw. This screw is 8½in. in diameter, and has a thread of 1½in. pitch. At the driving end it is fitted with heavy ball thrust bearings, and at both ends it is supported in gun-metal bearings sitting in recesses in the bed frame. The traversing saddle carrying the headstock is formed with a nut case, containing a long nut lined with Babbitt metal, having a 90 per cent. tin base. By removing the headstock the nut can be reached without lifting the saddle.

The saddle and headstock are traversed along the bed by means of a Metropolitan-Vickers reversing drive. The motor is of 15 horse-power, and takes current at 450 volts. It has a speed range of from 300 to 1150 revolutions per minute. The switchgear for it consists of a starting and reversing device, a speed-regulating switch and resistance, a double-pole circuit breaker, and two current-limiting switches. The drive is transmitted to the main screw through machine-cut spur gearing working in an oil-tight cast iron case. A range of speed from 6ft. to 20ft. per minute at the saddle is available, the length of stroke being 25ft. 6in.

On top of the saddle there is bolted a bottom bed piece carrying side quadrants at one end, and two lugs at the other, to which two similar lugs on the top bed piece above are pivoted to form a hinge. When bevelled edges have to be ground, the top bed piece is hinged upwards by means of a hand-operated worm and worm wheel lifting motion, situated close to the quadrants. In the centre of the upper bed piece is a fine-pitched screw for cross-traversing the headstock up to or away from the work. This shaft is operated through worm and spur gearing from a 20in. hand wheel on the side of the top bed piece. It can also be operated by means of a 2 horse-power motor fixed, as shown in the engraving, on the side of the lower bed piece, and driving the traversing shaft through an additional set of gearing mounted coaxially with the hinge of the two bed pieces.

The headstock is carried on a saddle sliding on the upper bed piece, and provided with a cast iron nut engaging the traversing screw. At the centre of the saddle is a pivot pin on which the headstock can be rotated by means of a worm and rack. By means of this swivelling gear, the headstock can be oscillated horizontally with the object of bringing fresh portions of the grinding segment faces into action.

The headstock supports the main spindle in two bearings consisting of cast iron boxes lined with white metal, having an 85 per cent. tin base. The front bearing is made in four parts, the bottom and two side pieces being adjustable for wear by means of wedges and set screws. The back bearing is in two parts. In rear of it, covering the end of the spindle, is a double ball thrust bearing, taking the thrust in both directions. The front bearing is 8¼in. in diameter, and the back bearing 7¼in. On each side of both bearings rings fixed to the spindle rotate in circular pockets or wells cast with the bearing boxes, the object being to prevent oil creeping into the electrical portions and short circuiting the supply.

The spindle is connected to the motor armature, and is keyed and provided with a nut for the reception of the disc carrying the grinding segments. There are ten of these segments and each is 22in. in length. The disc consists of a central casting, and a periphery formed of a steel plate, over which four wrought iron hoops are shrunk, the whole being machined together to secure true running. The grinding segments are held in place by means of set screws, with lock nuts, passing through brass nuts let into the pockets of the main casting. The set screws bear against steel plates, and wooden pads placed between their points and the inner faces of the stones. A steel hood covers the disc to minimise splashing. A water attachment for coupling to the main supply is fixed on the hood.

The 120 horse-power motor driving the spindle is of the Metropolitan-Vickers shunt wound interpole type, taking current at 450 volts, and running at 300 revolutions per minute. It is mounted directly on the headstock, and is controlled by switchgear consisting of a multiple lever starting rheostat with a no-volt release, a double-pole quick break switch, and fuses in an ironclad case. A distant push bottom stop control is also provided. The main spindle of the machine is lubricated with solidified grease, and all other parts with oil.

LANTERN SLIDES.—Ed. Bennis and Co., Limited, 28, Victoria-street, S.W. 1, inform us that they have a large number of lantern slides available for lecture purposes. The slides cover the whole field of development in connection with mechanical stokers and coal and ash elevating and conveying plant. A booklet giving the titles and a brief description of the slides will be sent on request.

STAINLESS STEEL.—In our issue of June 3rd, 1921, we summarised the replies received to an extended inquiry we had made as to the employment of stainless steel. That investigation showed that whilst the use of stainless steel was increasing, it was yet less well known than its qualities deserved, and that engineers were chary about its use. Since then, despite bad trade, both it and its near cousin, "stainless iron," have made some progress, and a material which is certainly destined to enjoy a great future has become more firmly established. Yet much remains to be done in the way of education of users, and we welcome the publication by Thos. Firth and Sons, Limited, of a book in which all the properties of stainless steel as ascertained in the laboratory and in practice are detailed. When we look at this volume we are astonished at the labour expended on the examination of these qualities. In one chapter alone we find that stainless steel has been subjected to no less than twenty-three different acids and to forty-seven other liquids and materials. The effects of all these reagents are detailed, and it is interesting to note the different results. Though a trade publication, the volume is in fact in most respects a scientific record of facts scientifically observed, and it is one that every engineer will do well to have by him for reference.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

American Orders for Pig Iron.

MIDLAND pig iron producers are finding their experiences more encouraging, and another Northampton furnace, it is announced, will be blown in at the end of this month. In forge iron business is still dull, the ironworks having little encouragement, in view of the present prices and demand, to work up material. It is in the foundry classes of pig iron that business is slowly but steadily moving upward. One of the features of this week's market has been an increased number of inquiries from the malleable trade and other founders for hematite pig iron. All classes of foundry iron, in fact, are being taken up more readily. Local quotations remain firm in character, with here and there a claim to have obtained prices slightly higher than those generally ruling. Holders of good Northamptonshire iron have been able this week to effect some sales at a premium, but the formal quotation at present remains unaltered, and in spite of the firmness of the market it is not probable that there will be any immediate general rise. Most furnace owners are relieved if they can find outlets for their production at the late prices, for it is feared that stocks are accumulating at some of the furnaces. It is understood here that the increase of 2s. 6d. per ton put on Cleveland iron seems likely to be followed by a further addition. Sales, in fact, are stated to have already been effected at higher than the market quotation. This state of things has a strong effect upon the Midland market. Quotations of local iron this week are:—North Staffordshire forge, 72s. 6d.; No. 3 foundry, 84s.; Northamptonshire forge, 70s.; foundry, 80s.; Derbyshire forge, 72s. 6d.; No. 3 foundry, 82s. 6d., at furnaces. The prevailing firmness in prices is largely an indirect consequence of the American buying of British iron. Although the coal strike in the United States is over and American buying of British coal is now nearing its end, the demand for pig iron to make up for the large arrears of production in the States at present shows no abatement. Practically all the supplies of Cleveland foundry iron have been bought up. Inquiries for Midland pig iron continue to be received from America. The specifications are mostly based on Cleveland quality, but it is understood that buyers for the States are open to receive pig iron of any standard make. Consignments are being sent to America from North Staffordshire and Northamptonshire. In the nature of things they cannot amount to a very great deal owing to the costly transport to the seaboard.

Belgian Iron in the Midlands

There are, unfortunately, few signs of general expansion in the manufactured iron trade of this district. For best iron certainly the outlook is brightening by the reports of improvement in the shipbuilding centres. Should this improvement develop it will also react on the chain and cable industries in the Black Country. In the common bar branches the improvement noted during recent weeks appears to have passed and business is again quiet. The demand for fencing bars, however, has been well sustained. Business is still being negotiated at £10 to £10 2s. 6d. Nut and bolt makers are not booking sufficient orders to keep their resources employed on the scale of two or three months ago. There is accordingly only a very meagre demand for raw material from this industry. Belgian shippers are again more actively in quest of the trade and have lowered their quotations. In more than one instance No. 3 bars have been offered for delivery in the Black Country at £8 7s. 6d., or 7s. 6d. lower than the price ruling a week or so ago. With the prospects so obscure consumers are not to be tempted to place more than small orders, notwithstanding the difference of about 30s. between the home and the foreign quotations. Galvanised sheets are moving, and the volume of inquiry gives promise of a fair autumn demand, enabling producers to uphold the higher quotations. Underselling by mills which were well off for spelter when the rise took place is still unsettling the market to some extent, but it is a diminishing factor. A little more business is passing in black sheets.

Steel Business

There is very little alteration to record during the week in the steel trade locally. Rather more buying has resulted from recent readjustments of prices, but there is no evidence of a general expansion. Buyers stubbornly persist in their refusal to commit themselves beyond immediate needs. The recent relapse in half products has not gone much further. There has been a little more buying lately of steel billets, and prices which have tended to weaken are steadier. Billets are now generally quoted at £7 to £7 5s., and sheet bars at somewhat less. Midland firms producing joists and angles continue their action of combination for price maintenance. The standard of £8 15s. is maintained, and the firms on the coast show a disposition to play into the hands of their Midland colleagues by refusing to quote at a figure which, with railway charges, would be competitive in this district. Foreign imports of steel are now quite negligible, and there is no prospect of their increasing in view of the demands which Germany is making upon her steel-making neighbours. The Belgian quotation for steel joists has risen from £6 11s. 6d. to £7, which, delivered in the district, would not give more than 7s. 6d. advantage over the home price. Deliveries of this and other foreign material, moreover, are increasingly difficult to obtain. There is very little being done in strip or hoops, and the finished trade in the majority of its departments remains dull. Wire prices show a downward tendency, and the demand for wire and wire products has slackened.

Coventry Works to Close Temporarily.

The Coventry works of the English Electric Company, formerly the Coventry Ordnance Works, are to be closed down temporarily owing to the general condition of trade and the continuing unsettled state of Europe. Since the conclusion of the armament work for the war a considerable portion of the factory has not been used, and under the English Electric Company the remaining portion has been utilised for the production of large turbines for power stations, and for these the export trade, so far as the European markets are concerned, is practically non-existent. The decision to close these works for the present will affect 800 workpeople, but the company makes it clear that the works will be re-started as soon as an increased volume of business justifies such a proceeding. The workmen have been given four weeks' notice and the staff eight weeks.

Increased Unemployment in Birmingham and Coventry.

Statistics of unemployment in the West Midlands area show a slight decrease for the week ended September 11th, the total being 180,834, as compared with 181,544 in the previous week. In several towns, however, increases are recorded, notably at Birmingham and Coventry, which show an addition of several hundreds to the ranks of the unemployed. The number of unemployed in these two areas are Birmingham 65,039 and Coventry 9640.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

THERE was a little more cheerfulness in the tone of the Manchester markets for iron and metals this week, but most of it, if not all, could be traced to the American buying, and this is a very unstable foundation on which to build hopes of a revival in the iron trade. For one thing, it may cease suddenly at any moment, and for another, it cannot become large enough to make any permanent impression on the conditions of the trade. Nevertheless, for the moment it is giving the industry something to do, and this is some comfort. Business men here are rather disturbed about the position in the Near East, and there were a few who anticipated a possible outbreak of war, and amongst them some who thought that this would result in another period of higher prices; but one may doubt whether any such war as is now possible would have much stimulating effect on the iron and metal markets. More probably the first effect would be depressing and not stimulating.

Metals.

Certain sections of the copper market seem to be rather better than they have been for some time, and there appears to be a little more buying of electrolytic ingot copper. This is a favourite kind of refined copper with the cable makers, and for electrical work generally; but for ordinary engineering work it is on much the same level as best selected ingots; and as the latter do not share in the better prices and increased demand, it seems safe to assume that general engineering business is no better than it was. The difference in the market price between electrolytic and best select is now £5 per ton, whereas the difference in copper content is almost infinitesimal. The increase in the consumption of refined copper is sometimes attributed to the smaller supplies of old copper which are now available, and the much higher prices which dealers are now offering for clean old copper, viz., up to £58 per ton, tend to confirm this view. The standard copper market was very much in the same condition as it is now when dealers were offering only £50 to £52 for clean copper scrap; so that there must be a considerable change in the conditions of supply and demand. The demand for manufactured copper and brass of a sort usually required by the engineering trades is very slow, but this may be partially accounted for by the prices still quoted. Every engineer must, of course, know that these prices are entirely artificial, and have no foundation in raw material; and hence it is natural for him to postpone buying as long as possible and to buy only what he must have in the hope that sooner or later these manufactured prices will be made to accord with the market price for standard and refined copper. Tin remains a very steady market, and so far as can be seen the present supply—of course, apart from the reserves which are supposed to be firmly held by the F.M.S. and Dutch Governments—is about equal to the present demand. The position seems to be balanced, and so long as there is no doubt about the attitude of the said Governments, one does not see that any serious disturbance is likely to take place. If the labour troubles in America are settled it is possible that there will be a little spurt of buying for that market. Lead is steady and quiet, and the backwardation on forward metal is less. This, from being as high as 25s. per ton for forward, has been reduced to about 7s. 6d. The American market remains quiet. Spelter has been a little firmer of late, and there seems to be some expectation in the market of an early improvement. Consumers appear to be rather more inclined to buy, and, on the other hand, the continental sellers are not offering. The imports of spelter were, however, larger last month than they had been for some time.

Pig Iron.

The position here in the foundry iron market is not greatly altered, except that Scotch foundry iron continues to get dearer, and is now almost out of the reach of the Manchester ironfounder. Some Scottish makers are asking 110s. per ton on trucks at the furnaces for No. 3, which means at least 130s. per ton when brought here through a merchant, or, in other words, £2 per ton more than common iron. There is now keen competition for orders for castings; it is not as it was a year or so ago, when the ironfounder could get any price he pleased; and hence costs have to be looked into very closely. East Coast hematite iron is still at a moderate price, and could certainly be brought here at fully £1 per ton below the cost of Scotch No. 3. Cleveland iron has again been advanced to 92s. 6d. and 95s. on trucks, but very few founders here now trouble themselves about Cleveland. Sellers of Derbyshire foundry iron are perhaps a little firmer than they were,

and ironfounders are more disposed to put out larger orders for supplies up to the end of the year, seeing that there is now no probability of lower prices until the American buying of pig iron has come to an end.

Finished Steel.

The tone of the market for manufactured steel is perhaps a little better. Some people have an idea that a new war in the East would improve trade for a time, but this is not accepted by most experts in the market. Meantime the confusion in Europe certainly makes business worse. There is no change in the prices asked here for plates and sections; and they are still higher than the corresponding prices in other districts. There is very keen competition for any good orders that may come along, and these seem always to be taken at prices which leave no profit.

Scrap.

Dealers in scrap iron and steel are still in a very depressed state of mind, and can do only a little business. For scrap steel there is no demand, but the ironworks are still open to take heavy wrought scrap at 65s. per ton. Ironfounders are buying very little cast scrap, and the relatively low prices do not tempt them. It seems absurd to have to sell best textile machinery scrap at 82s. 6d. per ton when 130s. has to be paid for Scotch No. 3; but the fact of its being absurd is not of much comfort to the scrap dealer.

Wages in the Engineering Trades.

There is just a possibility of a further stoppage of work in the engineering trades, due to a demand which has recently been made by the trades unions for an advance of wages of £1 per week for all their members who are engaged in the production of textile machinery. Although textile machinists form the only section of the industry which is at present prosperous, the employers are not likely to agree to the demand of the workers for two main reasons. First, such action would tend to sectionalise the industry, and, secondly, the differentiation of rates of pay would lead to confusion and friction. I understand that there is to be a meeting this week of the employers and the men's delegates, when the matter is to be discussed.

Cheap Money.

In spite of—or is it because of ?—the general industrial depression there would seem to be a large amount of capital available in this country for sound investments, judging from the low price at which the Manchester Corporation has recently been able to raise a loan of £1,000,000. The Corporation decided to issue yearling bills by tender, and the applications amounted to £1,333,000, the average rate of interest at which the bills were allotted being only £2 16s. 10.9d., which is roughly equivalent, allowing for the difference between discount and interest, to the yield on 5 per cent. National War Bonds maturing on September, 1923.

Forthcoming Exhibitions.

Two interesting exhibitions are to be held in Manchester next month, one devoted to town planning and the other to textile machinery. The former is being promoted by the Manchester and District Joint Town Planning Advisory Committee, a body formed by seventy local authorities. This Committee is by far the largest and most important in the country, and its influence covers an area of approximately 700 square miles, representing a rateable value of £15,000,000. The exhibition will be held at the Town Hall, and will be divided into sections including local plans and drawings and models from all parts of the world. A series of lectures on appropriate subjects will form an important feature of the exhibition, which will commence on October 9th, and remain open until the 14th. The textile exhibition is to be held at the City Hall, and will be opened on October 6th. I understand that the whole of the available space has been allotted, and that amongst the exhibits will be found several machines of quite original design.

Cotton Mill Statistics.

The extent of the world's cotton spinning industry and its distribution are both very clearly shown in the statistics given in a report issued by the International Federation of Master Cotton Spinners' and Manufacturers' Associations, whose headquarters are in Manchester. According to this report, the total number of spindles in the world on August 1st last is estimated at 154,555,267, an increase of 2,240,000 in twelve months. Of this total, British mills contain 56,605,176 spindles, an increase of 464,000 spindles in the year. On the European Continent there are 43½ million spindles, in the United States 36,493,000, in India 6,780,804, Japan 4,645,853, and in China 2,247,936 spindles. Out of a grand total of 154,555,000 spindles Great Britain owns rather more than one-third, although the consumption of cotton in America is more than two and a-half times as much as it is in these islands.

Salford Electricity Station.

The whole of the large contracts for the above municipal undertaking have now been let. The tender of Edward Wood and Co., amounting to £37,598, has been accepted for the steel work for the various buildings, and Sir Robert McAlpine and Sons' tender of £73,682 has been accepted for the excavations, concrete and brickwork, and Metropolitan-Vickers Electrical Company have obtained the contract for the turbo-generators. It will be seen, therefore, that the major portion of the work will be carried out by local firms. The total cost of the station per kilowatt will, I understand, compare very favourably with those of other similar undertakings which have recently been completed.

BARROW-IN-FURNESS, Thursday.

Hematits.

There is further evidence that the improvement in the hematite pig iron trade is substantial, and everything points now to a steady improvement all round. There have been further shipments to Baltimore, and a quantity is still on order for delivery in America. No doubt these American orders are the result of the coal strike there, and must not be taken as evidence of a return of a big trade with that country. As soon as they are able to produce this business will fall off, but in the meantime it has allowed local smelters to clear their stocks and has put them in a better condition as regards production at present-day costs. The continental trade develops, and there is an improvement in the home market, and last week Scotland took some heavy deliveries by sea from Barrow. As anticipated, the improved demand has resulted in the North Lonsdale Iron Company blowing in a furnace at Cleator Moor. There are hints of more furnaces being put in blast as trade improves. Manganese is in good demand, and there is a gradual increase in inquiries and orders for special classes of iron. Spiegel is in moderate demand.

Steel.

The steel trade is still engaged on rails, and the merchant mill is also busy at Barrow. There are orders which will occupy many weeks to complete for the hoop works. The foundries are partly engaged. A large shipment of rails on a White Star chartered boat for Queensland took place last week.

Iron Ore.

There is expected to be more life in the iron ore trade, and as more furnaces are put in blast so will the demand for native sorts improve. The same remark applies to foreign ore, one cargo of which arrived last week.

Shipbuilding and Engineering.

Shipbuilding is stagnant at the moment, but developments are anticipated very shortly. Engineering is dull, but here again there are signs of a little more business.

SHEFFIELD.

(From our own Correspondent.)

More Disappointments.

SHEFFIELD steel manufacturers, engineers and cutlers have suffered another series of disappointments during the past week. In the first place there was the Prime Minister's refusal to receive the deputation representative of Sheffield and other industrial centres which have suffered by reason of the curtailment and postponement of the naval programme, and whose hopes for some relief of the unemployment problem during the coming winter have centred on the promised placing of orders for the two new battleships. Readers of this column will have been to some extent prepared for this decision of the Prime Minister's, for I have previously indicated that in the view of many local people, Sheffield has been, since the Armistice, reposing a disproportionate expectation on the continuance of the armament orders which in the past have provided a very large measure of the city's prosperity. It is now admitted by many manufacturers that too much time has been spent in canvassing for a continuance of such orders, and too little attempt made to adapt plant for alternative purposes. Meantime other centres—at home and abroad—have made the turn-over from war to peace manufactures, and captured much of the trade which Sheffield could have secured if it had been less enamoured of the easy money represented by armament orders. The folly of this attitude is now generally recognised, but the Prime Minister has been the object of a good deal of purposeless and not very dignified reviling since his refusal to meet the deputation was announced. The outlook in the Near East has revived the hopes of those who still see nothing in store for Sheffield but a continuance of war preparations; but the workers here have discovered by the bitter experience of the last year or two that the prosperity from this kind of work is too short-lived and hectic while it lasts, and it is by no means certain that even here any prospect of renewed hostilities would be welcomed, despite the city's 40,000 unemployed.

America's Rebuff.

The other disappointment to which reference was made in the preceding paragraph is the unexpected passing of the Fordney Tariff Bill by the U.S.A. House of Representatives. This decision more particularly affects the makers of special and high-grade steels and cutlery. They had been hoping that the operation of the new tariff—practically prohibitive in its effects upon British imports—would be delayed if not avoided indefinitely as a result of the representations made by the Sheffield manufacturers who went over with this object; but it would seem that these representations and the opposition of American retailers who foresee the creation of high prices under the big monopolies that will be fostered by the new tariff, have alike failed to counter the strong sentiment in America which counts on making the country practically self-contained and self-sufficient industrially. At the same time there is just the possibility of a postponement of the Bill, for according to private advices received in Sheffield this week, it has not passed through its final stages, and that on account of strenuous opposition, the question had been indefinitely postponed. Inquiries made on behalf of Sheffield failed to elicit from the American Consul-General either confirmation or denial of this report, though it is significant, perhaps, that up to the time of writing the Embassy has received no official intimation of the passing of the Fordney Tariff, as would have been expected. Sheffield manufacturers and others concerned will, however, be ill-advised if they repose much hope on the prospect of the tariff being abandoned. They had far better equip themselves to meet keen, and possibly intensified, competition, though so far as the Sheffield cutlery trade, at any rate, is concerned, this advice is probably futile. Notwithstanding all the efforts of the University through the medium of its Trade Technical Societies and demonstrations, there is still an invincible opposition to the application of machinery and methods which would enormously reduce production costs.

An Uncertain Customer.

Meantime a good deal of activity in local furnaces and steel-making plant has resulted from America's big appetite for pig iron and steel, consequent upon the stoppage of her own coal and other supplies. Recent brisk conditions in the pig iron market have been almost entirely due to the demand from the United States. This, however, cannot continue indefinitely, and already there are indications that the American pig iron producers are making determined efforts to resume the operations that were interrupted by the coal strike. At present, however, orders on American account are still being placed freely here, and with depleted stocks at home also, the prospects for some time to come are fairly satisfactory. The iron and steel trade in North Lincolnshire also continues to improve; the mills at Frodingham have now been working full time for a fortnight, and another furnace is being prepared.

Sheepbridge and Staveley Activities.

Having regard to the industrial and financial conditions of the past year, the results shown by the Sheepbridge and Staveley Coal and Iron Companies, in their reports issued during the week-end, are by no means disappointing. The Sheepbridge Company shows a net profit of just under £80,000, and the directors report "an indication of improvement in some departments." The sinking of a new shaft has been resumed, a new blast-furnace and extensions to foundries have been completed and work in connection with the new ironstone field at Roxby in Lincolnshire is making progress. The Staveley Company directors state that the trading results have been the worst experienced in the whole period of the company's existence—and the present is the fifty-ninth annual report. Notwithstanding this, a profit of £176,124 is shown, but it is admitted that this is mainly accounted for by the refund of excess profits duty and the coal award. It is interesting to note that 700 of the company's workmen are shareholders. Thorncliffe Coal Distillation Company experienced a loss of over £33,500 on the year's working, but the directors "believe the prospects to be brighter and that a speedy recovery may be hoped for."

The Coal Position.

At Sheffield Coal Exchange business has been of a very lifeless character, many of the local pits having been idle during the week. Best steam hards are, however, urgently in demand both for home and export markets. Barnsley reports a falling off in the American demand, but there is a greater activity on the part of buyers in regard to forward business, and there are general signs of a revival, particularly in connection with continental markets, business with which, in the expectation of some local sellers, may soon approach pre-war dimensions. Best Yorkshire hards are already commanding up to 27s., but a good deal of business has been put through at from 21s. to 23s. Coking slacks and furnace coke are in demand.

NORTH OF ENGLAND.

(From our own Correspondent.)

Better Trade Outlook.

THE trade position in the North of England is showing signs of renewed life. The reports this week are certainly more encouraging than for a long time past, and a more optimistic feeling prevails regarding the outlook. At the moment there is quite a boom in the pig iron trade. This is principally due to the extraordinary heavy demand from America, which continues unabated. Already all the local makers have practically sold out their make of the better qualities of pig iron, up to the end of October, and in spite of the recent rises in price there has been a certain amount of business for delivery up to the end of the year. The shipments from the Cleveland district this month are likely to reach an exceptionally high total. The figures are well in advance of last month, and steamer tonnage has already been definitely stemmed for the transport of another 28,000 tons of local iron across the Atlantic. Although a fall of 2 dollars per ton is reported in the price of American iron, Cleveland iron can still be landed in the United States well below the price there, and buyers over here are operating, with the utmost confidence in the continuance of the trade for some time to come. At the same time it is to be recognised that this is but a passing phase. When America is able to resume normal production, she will be independent of European supplies, and high freight charges will probably apply the closure to this phase of commercial activity. This is no doubt one of the considerations which are preventing local ironmasters from increasing their productive capacity. They could sell considerably more than they are producing at present, but they want to be assured of a steady demand before they put more furnaces into operation. Still, the hope is entertained that idle plant will again be in operation before long. At the moment there are thirty furnaces in blast, out of a total of one hundred and fourteen, on the North-East Coast. Of these, seven are turning out Cleveland iron, eleven are making hematite, and twelve are producing other kinds of iron.

Cleveland Iron Market.

A very firm tone characterises the Cleveland pig iron market, and prices show a marked upward tendency. In addition to the heavy American demand, home consumers are now coming forward, and are anxious to secure supplies even for forward delivery. There is also a strong market for Cleveland iron north of the Tweed, whilst

sales are reported to the Midlands, notwithstanding the relatively low price of Derbyshire and Northampton foundry iron. No. 1 and siliceous iron are still quoted at 97s. 6d. per ton, but No. 3 G.M.B. Cleveland pig iron has been advanced a further 2s. 6d. per ton to 95s. No. 4 foundry is quoted at 90s., and No. 4 forge at 85s., but supplies of these qualities are very limited.

Hematite Pig Iron.

Little improvement is reported in the East Coast hematite pig iron trade. Makers hold large stocks, and are keen to sell mixed numbers at 89s. per ton, both for home consumption and export. No. 1 quality is obtainable at 89s. 6d. per ton.

Iron-making Materials.

The stagnation in the foreign ore trade continues, and as there is some pressure to sell, the quotation for best Rubio ore cannot now be put higher than 24s. per ton c.i.f., although even that figure is higher than the value of Mediterranean ores. There is still a strong export demand for coke, and ironmasters have to pay 26s. 6d. to 27s. per ton delivered at the works if they are seeking fresh supplies of good furnace coke.

Manufactured Iron and Steel.

The position in the manufactured iron and steel trade is gradually improving. More inquiries are circulating, and a few orders for rails and constructional work are reported to have been booked, but the volume of trade passing is still within comparatively narrow limits. The competition of cheap continental semi-manufactured steel is still severely felt, and a fair quantity of Belgian billets are being imported. Home quotations depend chiefly on destinations, cost of conveyance and long journeys having to be taken into consideration. For foreign trade, competition continues keen, and manufacturers are prepared to make substantial price concessions for export business.

The Coal Trade.

There has been a slight recovery in the tone of the Northern coal trade, and there is a rather more hopeful feeling throughout. During the past few days quite a number of new inquiries from the Continent for gas coals and steams for public utility concerns have been in circulation, and quotations have either been despatched or tenders are in course of preparation. In addition to these, there has also been something of an influx of general merchant inquiries, also from abroad, all of which together seems to have altered the outlook for the better, and have done not a little to counterbalance the setback which was occasioned by the loss of the American trade when the strike there was settled. Italian trade is still, however, very backward, and as a rule the buying for Germany is very slow just now. But, taking the export trade as a whole, there is a distinctly better prospect, which has been reflected in the healthier tone of the market in nearly every instance. The home trade still lacks volume and vitality, but there are indications of possible developments which, if realised, will further strengthen the forward position. Foreign coal inquiries for which tenders have been sent include 75,000 to 80,000 tons of best Northumberland steams for the Swedish State Railways, for shipment to the end of the year; 17,500 to 20,000 tons of best steams for the Latvian State Railways; and smaller quantities of gas coals for the Aalborg gasworks and the Frederikshavn gasworks. The Northumberland steam coal section is very steady. All the best brands of screened steams have improved in tone, and are at higher figures direct from the collieries, any concession being only obtainable in second hands. Second screened steams are also very steady, with a correspondingly good market for all classes of steam smalls. Durham coals have also benefited to some little extent by the heavier bookings and some of the weak spots have been eliminated, so that the position is less patchy than it was a week ago. Most of the well-known brands are steady at full quoted prices. The coke market is strong for any make for prompt delivery. Both beehive and patent foundry are scarce and firm, while gas coke is none too plentiful.

SCOTLAND.

(From our own Correspondent.)

Home Markets Dull.

LOCAL demands in practically all industrial markets are very discouraging. Producers were hopeful that the end of the holiday would bring an improvement all round, but as week succeeds week, conditions remain unchanged. Only a fairly regular export demand enables the works to maintain a certain degree of activity, which, it is said, is not of a very profitable nature. The autumn outlook gives little hope of a change for the better.

Here and There.

From various quarters come reports of new contracts, and these, of course, always engender the hope that more work may follow. It is reported that the Fairfield Shipbuilding and Engineering Company, Limited, Govan, is to proceed with the construction of a liner for the Union Steamship Company of New Zealand. This contract was entered into just before the end of the war, but was cancelled owing to the high costs of production. Report of another shipbuilding order has come to hand in the shape of an 8000-ton cargo steamer to be built in a yard on the lower reaches of the Clyde. From Motherwell comes the intimation of further contracts secured by the Motherwell Wagon and Rolling Stock Company, Limited, for the construction of wheels and axles to the order of the following railways:—230 pairs for the North British Railway Company, 500 pairs for the Caledonian, 100 pairs for the East Indian, 300 pairs for the Rohilkund and Kumaon, and 200 pairs for the Burma Railways. Furthermore, an order of interest has been secured by the Albion Motor Company, Glasgow, from the India Office in the shape of fifty Albion 30-cwt. motor lorries of an improved type. This order is the successful outcome of a specially severe test.

Steel and Iron.

Certain steel works report a little more inquiry on export account, but the general situation in the industry is far from satisfactory. Even when orders do come to hand, quantities are much less than formerly, and makers have had to modify their ideas as to what a rolling quantity amounts to. Steel plates still continue very short of orders, and current prices could be cut for a favourable order. There is a little more inquiry for steel for railway and structural work abroad, and sheets of the thinner gauges also have comparatively fair orders. The situation in the bar iron trade is far from bright. Business is scarce all round, and only a small portion of the plants are in operation. Prices of scrap material are very firm, but only a moderate turnover is reported. The inquiry for pig iron fluctuates, but fair quantities still change hands. Supplies are scarce and quotations remain firm. It is probable that additional furnaces will be put in blast soon.

Coal.

Business in Scotch coal has fallen off to a considerable extent, and markets were dull throughout the past week. Anticipation of orders from Canada have not been realised, and orders in hand for October are of small bulk. Few descriptions of round coal are moving freely, and Lanarkshire ells, in particular, have weakened. Small stuffs are now in much the same position as round fuel. A number of vessels still await cargoes, chiefly at East of Scotland ports, but forward business is greatly reduced. The general outlook is unfavourable. Aggregate shipments for the past week amounted to 337,750 tons, against 364,102 tons in the preceding week and 340,489 tons in the same week in 1913.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

NOTHING has developed during the past week to modify one's opinion regarding the rather unsatisfactory outlook for the steam coal trade. The demand is quiet, and values are, as a consequence, displaying a downward tendency. There is still a fair amount of coal to be shipped to the States and Canada, but unfortunately the amount of fresh buying for these countries is very restricted. It cannot be said that business for America and Canada has come to an end; but there is no doubt that the volume of future operations will be such as to have little or no influence upon the market as a whole. This being the case, coalowners and exporters have to turn to the regular outlets for coal from this district, but the past week has shown that European consumers are not prepared to resume purchasing where the Americans and Canadians have practically left off. The foreign exchanges are against them, and, furthermore, being of the opinion that prices must come down, they prefer to wait until they think that values have settled down. This point has apparently not been reached, because while there is a fair inquiry the yield of actual business is comparatively small. It is interesting to note that up to the end of last week the number of cargoes shipped to America and Canada since July 29th last was 165, amounting to 995,714 tons, but actual charterings on the open market from July 17th to the end of last week numbered 201, to lift a total of 1,464,800 tons. Apart from the tonnage which has been chartered on this side, some firms have taken up American tonnage on the other side at rates more favourable than those which have had to be conceded here.

Wages and Non-unionism.

Two questions which are figuring very prominently just now relate to wages and non-unionism. The Coal Conciliation Board met again on Tuesday of this week to consider the application of the Miners' Federation for a subsistence allowance for the lower-paid workmen; but after about two hours' discussion no agreement was come to, and consequently the matter was referred to the independent chairman, Lord Buxton, for his decision. According to a report of a meeting of the Rhondda No. 1 district of miners, a resolution was passed instructing the Executive Council not only to demand a subsistence wage for the lower-paid workmen, no matter what the consequences might be to the industry, but to put in a demand for a 60 per cent. increase in wages, in order to bring wages up to a living standard. As regards non-unionism, it looks very much as if there is a very good prospect that the miners will tender notices on October 2nd, to operate in fourteen days from that date, in order to compel non-unionists to fall into line. The owners have made it clear that they are not prepared to co-operate in influencing workmen to join the Federation. The opinion of the various districts was sought over last week-end, and many districts have sent in reports to the general secretary that they approve of the proposal to tender notices on the date above-mentioned; but in other cases a recommendation is made that notices should be postponed for a month, and that in the meantime an intensive campaign should be conducted against the non-unionists.

Substitutes for Coal.

In an article relative to the demand of the miners for a higher wage rate and the need for a reduction in the cost of production, the secretary of the South Wales Coalowners' Association draws attention to the expedients adopted by foreign countries who in pre-war days were dependent on British coals, and mainly on South Wales coals, with a view to economising the consumption of coal and therefore to a diminution in the demand for supplies from this country. These economies have taken the form of the development of water power, the increased consumption of oil, and the exploitation of lignite, peat, and new coalfields in foreign countries. The development of water power, particularly by the construction of hydro-electric stations, has been very actively carried out in France, Italy and elsewhere. As regard the exploitation of substitutes, Mr. Finlay Gibson points out that the output of lignite in Germany has been increased from about 7,250,000 tons per month to 12,250,000 tons per month; in Italy the development of peat beds is in active progress, and Italy is now importing from the United Kingdom an average quantity of only 500,000 tons compared with over 800,000 tons in 1913. Similar enterprises are in progress in other countries. Moreover, in consequence of the high prices of British coals, and especially of Welsh coals, the development of the native resources of foreign countries is more active than ever. The Netherlands have more than doubled their pre-war coal output. The Spitzbergen coalfield has been so successfully developed that coal is now regularly shipped to Norway and Sweden. Spain and South Africa have also increased their outputs of coal, and South Africa as a result, is a more active competitor than ever with Britain in the Eastern coal trade. The competition of oil is also dealt with at length, and it is mentioned that the quantity of coal now required by the British Admiralty for naval consumption is almost negligible. At all the important coal depôts on the ocean routes of the world, oil tanks are being constructed, and notwithstanding the fact that there is in the world to-day 14,000,000 gross tons more of shipping than in 1914, we are supplying less coal for bunker purposes both at home and foreign ports than we were shipping in pre-war days.

Current Business.

The tone of the steam coal market has been on the dull side, and the inquiry coming along is very meagre. Foreign consumers are not at all eager to buy at the current prices, notwithstanding that they are lower than was the case a week ago. In order to effect a sale of a cargo, exporters have to discount existing values. Some of the leading collieries are pretty well stemmed for the present month; but for any further business they are compelled to come down in their ideas or else business goes past them. Best Admiralty large can be booked for early October loading at 27s. 6d. without difficulty, and even at a trifle less, while second qualities are obtainable at 26s. to 26s. 6d. Monmouthshire coals are quiet, but dry coals are very steady at round about 28s. 6d. to 29s. Small coals are more plentiful, and the best can be secured at 17s. 6d. or a shade less. Patent fuel meets with a very moderate inquiry. Even anthracite coals are not quite so firm, especially large coals, but sized coals are relatively steadier.

Coalfield Non-unionism.

The Executive Council of the South Wales Miners' Federation has decided to call a coalfield conference for Saturday, 30th inst., to consider the whole question of non-unionism in the coalfield. Reports from district meetings show a large majority in favour of tendering notices on October 2nd.

Swansea Metal Exchange.

The tin-plate trade is very quiet, and prices are barely maintained. They are, in fact, below the cost of production, and it is rumoured that unless the conditions improve some works will have to close down temporarily.

CABLE advices from America state that the railway shopmen's strike has been settled. It has been running since July 1st, and it furnishes a very important object lesson in that it arose out of the refusal of the men to accept an award of the Railway Labour Board established under the Transportation Act, 1920. This, like our own National Wages Board, is composed of representatives of the companies, the brotherhoods and the public. The companies apparently were uncertain as to the justice of the award, as they were willing, provided the men resumed work, that the question should be reconsidered, but they made it a condition that the men who struck work should lose their seniority. Even this point the companies were willing to submit to the Labour Board; but the men would not give way. They have, however, at last agreed to accept the award, but not all the companies will now take the men back. A good deal of the work is non-technical. The men are not shopmen in our use of that term. They are carriage and wagon examiners, greasers, &c. In many of the states there has been a deal of unemployment and the strikers' places have been filled. As a consequence of this and other conditions, the agreements as to renewing work have been made with individual companies and not in general. Altogether, the dispute has gone badly for the men, who have suffered their first defeat for many years.

EVIDENCE continues to reach the Ministry of Commerce for Northern Ireland which shows that misapprehension continues to exist among consignors in England, Scotland and Wales with regard to the conditions under which goods may be imported into Ulster. A number of the merchants in Belfast and the North are still receiving requests from consignors on this side of the Channel to forward permits issued by the Irish Home Office to cover the importation of certain goods into Northern Ireland. The Northern Ministry of Commerce points out that the decree recently issued by the Provisional Government of the Irish Free State does not in any way apply to Northern Ireland. Decrees issued by the Provisional Government have force only in the area under its control, and do not apply to the six counties of Londonderry, Antrim, Down, Armagh, Fermanagh, and Tyrone, which are under the jurisdiction of the Government of Northern Ireland. The commodities enumerated in the decree are:—(*a*) Petroleum spirit, naphtha, benzol, petroleum, paraffin oil, fuel oil, motor spirit, or other substance capable of producing power; (*b*) any lubricating oil; (*c*) motor cars and motor cycles; any parts or accessories of or for motor cars or motor cycles; (*d*) any sheet metal (except galvanised iron and tin-plates); (*e*) any iron plates; (*f*) any apparatus or contrivance for or capable of being used for communication by wireless telegraphy or any part of or accessory for any such apparatus.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	22/6
(1) Spanish	22/6
(1) N. African	22/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 7 6	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 9 9	4 9 0
No. 1	4 9 6	4 9 6
Cleveland—		
No. 1	4 17 6	4 17 6
Silicious Iron	4 17 6	4 17 6
No. 3 G.M.B.	4 15 0	4 15 0
No. 4 Foundry	4 10 0	4 10 0
No. 4 Forge	4 5 0	4 5 0
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 12 6	—
„ „ Foundry	4 4 0	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
„ Forge	3 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 3 6	
Forge	3 17 6	—
(3) Lincolnshire—		
Basic	4 6 6	—
Foundry	4 6 6	—
Forge	4 6 6	—
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 4 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 10 0	10 10 0
Best „	12 0 0	—
N.E. COAST—		
Crown Bars	11 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best „	13 0 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	10 10 0 to 11 5 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	9 15 0 to 9 17 6	
Gas Tube Strip	11 0 0 to 11 5 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 10 0	—
Ship Plates ½in. and up	9 0 0	—
Sections	8 15 0	—
Steel Sheets ⅛in. to ½in.	10 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 0 0 to 9 10 0	—
Angles	8 15 0 to 9 0 0	—
Boiler Plates	12 10 0	—
Joists	9 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	13 10 0	—
Hard Billets	8 5 0	—
Soft Billets	7 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0	—
Light „	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 0 0	—
Boiler „	13 10 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
„ (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
„ (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	8 15 0	—
Soft „	7 5 0	—
Hoops	12 5 0	—
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	9 5 0 to 9 10	
Billets and Sheet-bars	7 0 0 to 7 2 6	
Gas Tube Strip	10 0 0 to 10 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	16 7 6 to 16 15 0	
Angles	8 15 0 to 9 0 0	
Joists	9 0 0 to 9 10	
Tees	10 0 0	—
Bridge and Tank Plates	9 0 0 to 9 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/- to 19/3
Block Tin (cash)	158 15 0
„ (three months)	159 17 6
Copper (cash)	62 12 6
„ (three months)	63 5 0
Spanish Lead (cash)	24 0 0
„ (three months)	23 7 6
Spelter (cash)	31 12 6
„ (three months)	30 17 6
MANCHESTER—	
Copper, Best Selected Ingots	67 10 0
„ Electrolytic	71 0 0
„ Strong Sheets	94 0 0
„ Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
„ Condenser	0 1 2½
Lead, English	25 10 0
„ Foreign	24 5 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/9½ per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24	10/-
„ 6 p.c. to 8 p.c. „	£23 10 0	9/-
„ 8 p.c. to 10 p.c. „	£23 10 0	8/-
„ Specially Refined		
Max. 2 p.c. carbon	£60	26/-
„ 1 p.c. „	£70	30/-
„ 0·75 p.c. carbon	£75	37 -
„ carbon free	1/7 per lb.	
Metallic Chromium	5/- per lb.	
Ferro Manganese (per ton)	£15 for home.	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale	5/- per unit
„ „ 75 p.c.	23 10 0 scale	6/- per unit
„ Vanadium	18/- per lb.	
„ Molybdenum	6/- per lb.	
„ Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£160	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100	

(British Official.)

FUELS.

	Export.
SCOTLAND.	
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	21/-
„ „ Ell	21/6
„ „ Splint	21/6 to 21/9
„ „ Trebles	22/9
„ „ Doubles	21/9
„ „ Singles	20/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	21/-
„ „ Splint	21/6
„ „ Trebles	22/9
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	20/6 to 23/-
Screened Navigation	23/-
Trebles	23/6
Doubles	22/6
Singles	20/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	22/-
Secondary Steam	21/3
Trebles	23/-
Doubles	22/6
Singles	21/-
ENGLAND.	
(8) N.W. COAST—	
Steams	30/-
Household	46/8 to 57/6
Coke	33/-
NORTHUMBERLAND—	
Best Steams	24/- to 24/6
Second Steams	23/- to 23/6
Steam Smalls	14/- to 15/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	24/- to 24/6
Second	21/- to 22/-
Household	25/- to 28/-
Foundry Coke	37/- to 40/-

	Inland.
SHEFFIELD—	
S. Yorks. Best Steam Hards	21/- to 22/-
Derbyshire Hards	19/- to 20/-
Seconds	18/- to 20/-
Cobbles	17/- to 19/-
Nuts	15/- to 16/-
Washed Smalls	10/- to 11/-
Best Hard Slacks	12/- to 13/-
Seconds „	9/- to 10/6
Soft Nutty „	7/6 to 8/6
Pea „	7/- to 8/-
Small „	2/- to 4/6
House, Branch	30/- to 33/-
„ Best Silkstone	27/6 to 29/-
Blast Furnace Coke (Inland and Export)	20/- to 30/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	26/6 to 27/-
Second „ „	25/6 to 26/-
Best Dry Large	28/6 to 29/-
Ordinary Dry Large	27/6 to 28/-
Best Black Vein Large	25/- to 25/6
Western Valley „	25/- to 25/6
Best Eastern Valley Large	24/- to 25/-
Ordinary „ „	22/6 to 24/-
Best Steam Smalls	16/- to 17/-
Ordinary „	14/- to 16/-
Washed Nuts	25/- to 30/-
No. 3 Rhondda Large	28/- to 29/-
„ „ Smalls	20/- to 21/-
No. 2 „ Large	21/6 to 22/6
„ „ Through	18/6 to 19/6
„ „ Smalls	13/- to 14/-
Coke (export)	35/- to 40/-
Patent Fuel	27/- to 29/6
Pitwood (ex ship)	28/6 to 30/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	57/6 to 60/-
Seconds	52/6 to 55/-
Red Vein	47/6 to 50/-
Machine-made Cobbles	70/- to 72/6
Nuts	70/- to 72/6
Beans	45/- to 50/-
Peas	24/- to 25/-
Breaker Duff	8/6 to 9/-
Rubbly Culm	14/- to 14/6
Steam Coals:	
Large	25/- to 27/6
Seconds	24/- to 25/-
Smalls	14/6 to 16/-
Cargo Through	19/6 to 22/6

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Reconstruction Work.

THE hesitation of those entitled to reparation to place orders for the material they require from Germany has been dispelled by the facilities which are now offered them for dealing direct with German firms. Past experience with the old Comité d'Achats, which too often supplied everything except what was needed, did not encourage people in the devastated areas to order what they wanted through Government channels, and now that they are permitted to select what they require either from catalogues or from visits to German works, and specify the firms which are to supply the material, orders are beginning to arrive in considerable numbers. In the Department of the Somme alone, the Reconstitution Service has, during the week, sanctioned the placing of orders to the value of about 3,000,000f., and as the demands are accumulating, it is likely that the work will be carried on much more actively than had been anticipated. Some firms are sending in demands for the entire reconstruction and equipment of works. The requirements are very largely for machinery and machine tools, building material representing only a small part of the total. German firms are flooding the devastated regions with circulars and catalogues, and it is evident that the reconstruction work will provide plenty of activity in Germany, payment being made, of course, by the German Government on account of reparations. An important deputation of German manufacturers, headed by Herr Hugo Stinnes, is expected to make a thorough inspection of the devastated departments next month. It is significant that the workers in Germany have undertaken to do all they can to assist manufacturers in supplying the material to France, while the colliers have agreed to work an extra hour a day to permit of heavier consignments of coal to this country. This considerable importation of German goods into France cannot fail to have some influence upon business here. It is generally believed that the lower prices at which a vast amount of German material will be delivered into the devastated regions will have the effect of bringing down prices everywhere, and it is certain that a great deal of building work is being suspended with the idea that cheaper materials will be procurable in a very short time.

Railwaymen.

The new decree concerning the working hours of railwaymen has given rise to a good deal of discussion on account of what appeared to be the refusal of the Government to accept in its entirety the proposal of the Superior Council of Railways for an extension of hours under conditions that would mean a longer working day for the same amount of wages paid. Under this proposal, the men would be required to work an additional 300 hours a year without extra pay, which meant that the average day would be nine hours, while a further 150 hours a year could be worked overtime with pay. The Government, however, declines to touch the principle of the eight hours' day, although it will be no longer rigidly enforced, and by fixing the number of working hours at 2504 a year, with an additional 450 hours' overtime, its object is to give a sufficient elasticity to the working day, whereby the companies may be able to adapt labour to the varying requirements of the service. The new arrangement also implies that the working hours will be effective, and will no longer include the time when men engaged in intermittent work have nothing to do. In this case, the working day may be twelve and even fifteen hours, so that for intermittent duties there will be two shifts instead of three as at present.

Living Costs.

The strike in the engineering trades at Havre shows little sign of coming to an end, and the frequent interruption of work at the docks is causing so much inconvenience that several shipping companies are reported to be considering the advisability of going elsewhere unless the labour trouble can be permanently settled. All offers of arbitration have been rejected by employers, who affirm that if the men refuse to make a sacrifice of 10 per cent. in wages, it will be quite impossible to carry on business at all. Matters are so completely at a deadlock that the Havre Chamber of Commerce is trying to find a way out of the difficulty by appointing a Commission to investigate the cost of living, and see if it will not be possible, with the aid of the shopkeepers, to reduce prices *pari passu* with wages. As the shopkeepers have been particularly sympathetic with the strikers, it is hoped that they will make a sacrifice on behalf of the men, for it is clear that employers are unable to give in over the question of wages, and if the men find that what is offered them does not constitute a living wage, they must either give up all hope of finding work in the district or help to do something to bring down the exaggerated cost of living.

Rail Motors.

The State Railways are continuing their experiments with trains hauled by petrol motor vehicles with which they hope to realise big economies on local lines where the services are at present run at a loss. It has been found necessary to reduce the number of trains to a minimum, and in certain cases even to suppress them altogether, but if the results of the trials carried out some months ago on a line near Mantes should be confirmed by the prolonged test which is to be made on a particularly difficult line between Mortange and Sainte-Gauburge, in the Department of the Orne, the employment of petrol trains will be rapidly increased, until they replace steam locomotives on all the local lines. The distance between the two towns is 72 kilom., and the train will accomplish the journey each way daily. If the results are satisfactory, the State will immediately order a number of petrol vehicles to be put in service on other lines. The first experiments were made with a modified omnibus chassis weighing 14¼ tons. It hauled two coaches at speeds up to 30 miles an hour, and at a cost that showed it was quite possible to make the local lines with limited traffic self-supporting.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

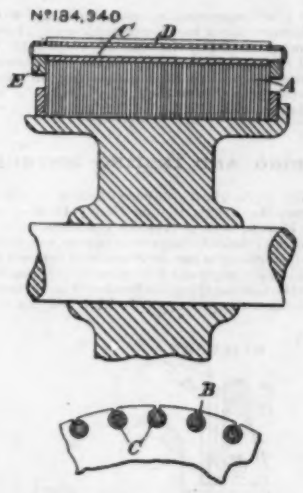
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

184,340. July 5th, 1921.—IMPROVEMENTS RELATING TO INDUCTION ELECTRIC MOTORS, George Herbert Fletcher, of Seaton Park-avenue, Ashton-on-Mersey, and the Metropolitan-Vickers Electrical Company, of 4, Central-buildings, Westminster.

THE laminated ring A of the rotor is provided near its periphery with a plurality of holes forming longitudinal conductor slots B, which, as shown, may be of the partially open type. The rotor conductors are formed of a core C of good conducting non-magnetic material such as copper and an enclosing outer layer or covering sleeve D of magnetic material. The sleeves may be of the same length as the laminated ring A, whilst the inner cores C project beyond both ends of the ring and are connected

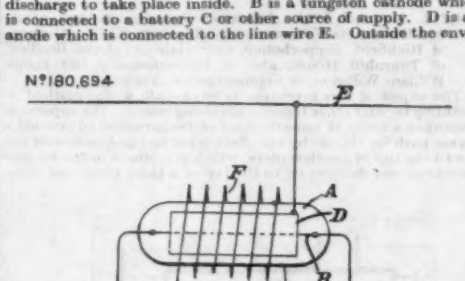


together to form the squirrel cage winding by means of solid end rings E of copper or other material of suitable conductivity, which, as shown, may be provided with holes through which the ends of the cores C may be passed and secured by riveting, welding or otherwise. Since, however, the end rings often constitute a relatively large part of the rotor resistance, the same principle may be applied to the end rings; that is to say, the cores and sleeves of the rotor conductors may be connected respectively to the cores and enclosing coverings of composite end rings of a similar nature to the composite conductors. The stator may be of any type. At the moment of starting the currents flow mainly through the sleeve D and a good starting torque is secured.—*April 17th*, 1922.

TRANSMISSION OF POWER.

180,694. May 26th, 1921.—IMPROVEMENTS IN AND RELATING TO PROTECTIVE DEVICES FOR ELECTRIC CIRCUITS, *The British Thomson-Houston Company, Crown House, Aldwych.*

The device described in this specification offers a discharge path of high conductivity at voltages only moderately higher than the normal voltage. The device consists of an elongated envelope A composed of brass, copper or other material. The envelope is evacuated to a degree which will enable an electron discharge to take place inside. B is a tungsten cathode which is connected to a battery C or other source of supply. D is an anode which is connected to the line wire E. Outside the enve-

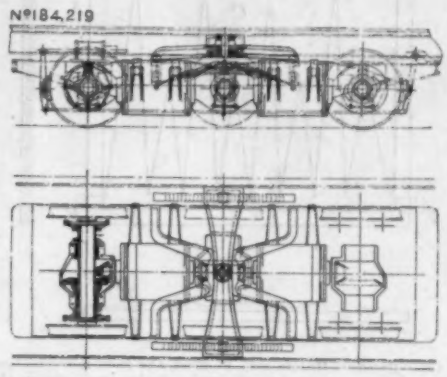


lope is a solenoid F, which provides a magnetic field and which causes the electrons emitted by the cathode to be deflected and made to travel in a spiral path about the cathode on the way to the anode. When a voltage surge occurs in the line or when a lightning discharge causes a rise of voltage above the critical value, a discharge of current occurs, and when the high voltage condition no longer prevails the condition of non-conductivity in the device is immediately restored. The specification contains a number of diagrams showing how the device may be used in connection with electric supply systems.—*August 17th*, 1922.

TRAMWAYS AND RAILWAYS.

184,219. May 30th, 1921.—IMPROVEMENTS IN AND RELATING TO ELECTRIC DRIVE FOR VEHICLES, *Edward Charles Robert Marks, of 57 and 58, Lincoln's Inn-fields, London, W.C. 2.*

One or several motors are arranged along the longitudinal axis of the chassis, and when use is made of several motors, their shafts are coupled together by gears, endless screws, or other transmission members, the motors forming together with the driving members of the axles a rigid arrangement carried by the shaft and not supported by the axles. In the case of two axles the driving members may consist of hollow shafts traversed by a corresponding axle driven by the motor by means of gears or other transmission members, the connection between the hollow shafts and the axles being effected by means of arrangements allowing the displacement of the axles relatively to the hollow shafts. The connection may, for instance, be obtained by means of springs allowing the desired displacement whilst imparting a certain resiliency to the transmission. In the case of a vehicle or of a bogie with three axles, use is made of two motors arranged along the longitudinal axis on each side of the



middle axle, the motors having their driving shafts coupled together through the intermediary of gears, endless screws or other transmission members secured on the driving shaft of the wheels of the middle axle. The frameworks of two neighbouring motors are connected by a casing that supports the bearing of the hollow shaft situated between the two motors. Where the line is fed by a high-voltage current the scheme enables the motors to be coupled in series, in order that each armature shall be subjected to one fraction of the voltage of the line only.—*July 31st*, 1922.

MOTOR CARS AND ROAD TRAFFIC.

184,305. October 21st, 1921.—IMPROVEMENTS IN RE-TREADING AND MANUFACTURE OF PNEUMATIC MOTOR TIRES, William Thomson, of Chichester House, Double-street, Spalding, Lincs.

The tire is built up in the usual manner up to the point before the walls and tread are finally put on. At this stage the prepared woven wire strip A is laid on the underlying rubber compound B and is rolled into the compound until the compound percolates through the mesh, when another layer of rubber compound B is rolled upon it and both rubbers then closely adhere. The final layers of rubber compound are placed on the

walls and the tread upon the centre and around the tire in the usual manner. The whole is then placed in the mould or pan and vulcanised in the usual way. With a tire constructed in accordance with this invention the woven wire and rubber compounds become homogeneous and flexible, and with the wire extending around the tire and from bead to bead, disintegration of the tire fabric is prevented and bursting cannot occur.—*August 17th*, 1922.

LIGHTING AND HEATING.

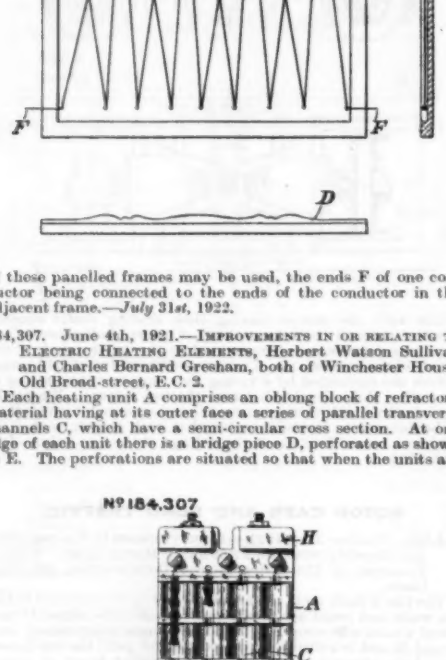
184,250. May 3rd, 1921.—A NEW OR IMPROVED PROCESS FOR THE COMBUSTION OF PULVERISED FUEL, Charles Edward Blyth, of Stockton, near Rugby.

In processes for the combustion of fuel in which a mixture of pulverised fuel, such as coal, and an inflammable liquid, such as oil, is used, the relative proportions of the pulverised fuel and inflammable liquid have previously been such that the latter acts as the carrier for the former. This involves the use of a comparatively large percentage of the liquid content. According to this invention the relative proportion of inflammable liquid per unit weight of powdered fuel is such that after treatment therewith the pulverised fuel retains its property of diffusion in air in a finely divided state of suspension, and, together with the air, constitutes a carrier for the inflammable liquid. It has been found that the addition of such a small proportion as .07 per cent. of inflammable liquid, such as paraffin, to powdered fuel—such, for example, as coal—provides a finely divided fuel which readily ignites and burns with complete combustion irrespective of the presence of a considerable quantity of foreign matter. A feature of the invention is that the inflammable liquid is added to the fuel before or during pulverisation, and according to one arrangement the inflammable liquid and raw fuel meet together at the hopper of the pulverising machine and pass through a drying and pulverising process together.—*August 3rd*, 1922.

184,240. April 30th, 1921.—IMPROVEMENTS IN ELECTRIC RADIATORS, John Robert Quain, of 17, Victoria-street, S.W.

The conductor A is arranged in zigzag form and is supported

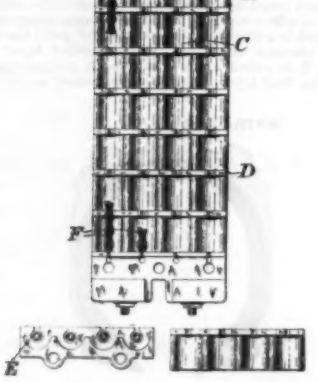
on insulating studs B fixed to the back of the case or frame C so as to leave a space between the conductor and the back of the frame. When the panel or cover D is attached to the edges E a space is left between the conductor and the panel. Any number



of these panelled frames may be used, the ends F of one conductor being connected to the ends of the conductor in the adjacent frame.—*July 31st*, 1922.

184,307. June 4th, 1921.—IMPROVEMENTS IN OR RELATING TO ELECTRIC HEATING ELEMENTS, Herbert Watson Sullivan and Charles Bernard Gresham, both of Winchester House, Old Broad-street, E.C. 2.

Each heating unit A comprises an oblong block of refractory material having at its outer face a series of parallel transverse channels C, which have a semi-circular cross section. At one edge of each unit there is a bridge piece D, perforated as shown at E. The perforations are situated so that when the units are

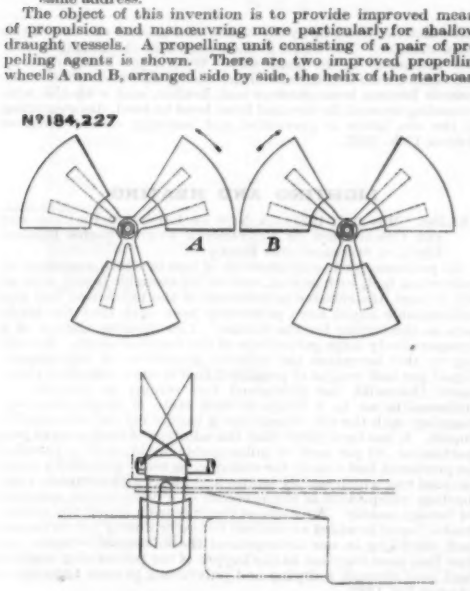


strung together as shown in the upper illustration and a spiral heating wire F is passed through the perforations, the central axis of the wire will lie along the axis of the semi-circular channels C. The elements are provided with terminal blocks H, which may also be composed of refractory material.—*August 17th*, 1922.

SHIPS AND BOATS.

184,227. April 16th, 1921.—IMPROVED MEANS FOR PROPULSION OF SHIPS, Maurice Edward Denny, of Leven Shipyard, Dumbarton, and Frederick Thomas Edgecombe, of the same address.

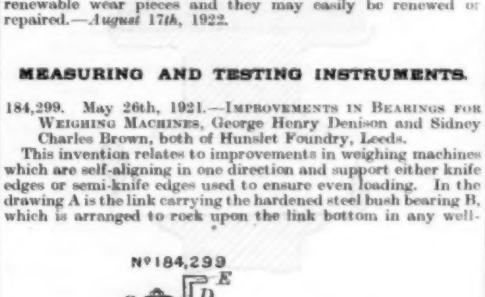
The object of this invention is to provide improved means of propulsion and manœuvring more particularly for shallow-draught vessels. A propelling unit consisting of a pair of propelling agents is shown. There are two improved propelling wheels A and B, arranged side by side, the helix of the starboard



wheel being right hand, while that of the port wheel is left hand, so that when they are propelling the vessel ahead the upper parts turn outwards and away from each other as indicated by the arrows. This relative arrangement of the pitches of the wheels is found of considerable advantage in manœuvring. The wheels are placed at some distance aft of the aftermost submerged portion of the structure of the ship (indicated by dotted lines in the lower drawing), a distance equal to about 75 per cent. of the overall diameter of the wheel. It will be noted that the diameter of the wheels is substantially greater than the draught of the vessel.—*August 16th*, 1922.

184,415. December 19th, 1921.—IMPROVEMENTS IN HOPPER DREDGERS, HOPPER BARGES AND THE LIKE, Wm. Simons and Co., Limited, William Brown, and Walter Brown, all of London Works, Renfrew.

The primary object of this invention is to enable the valve seat to be renewed or repaired without removing the valve or cutting away parts of the flooring keelsons. The sloping sides A of the hopper and cross keelsons B are extended to the ship's bottom, being deflected near the bottom and continued vertically, leaving a rectangular passage in the shell plating. C denotes

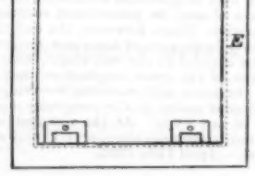


a rectangular plate presenting a central opening, the plate being supported between upper and lower angle irons D and E. F is a seating member carried by the plate C. Renewable wear pieces G extend all round the lower edge of the rectangular passage. When the vessel is in dry dock access can be gained to the renewable wear pieces and they may easily be renewed or repaired.—*August 17th*, 1922.

MEASURING AND TESTING INSTRUMENTS.

184,299. May 26th, 1921.—IMPROVEMENTS IN BEARINGS FOR WEIGHING MACHINES, George Henry Denison and Sidney Charles Brown, both of Hunslet Foundry, Leeds.

This invention relates to improvements in weighing machines which are self-aligning in one direction and support either knife edges or semi-knife edges used to ensure even loading. In the drawing A is the link carrying the hardened steel bush bearing B, which is arranged to rock upon the link bottom in any well-

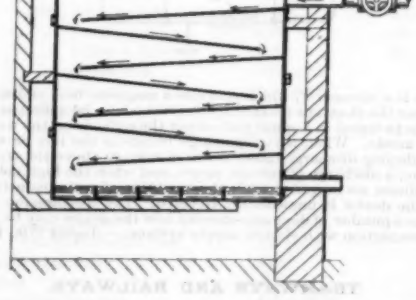


known manner, to render it self-aligning. The pivot C consists of a screw, fitted into the top of the link A, and is secured by a lock-nut and has a conical pivot end which rests in a recess G drilled into the lug D forming part of the box or frame E. In the plan four lugs are shown, which carry a similar number of links.—*August 17th*, 1922.

MISCELLANEOUS.

184,242. May 2nd, 1921.—IMPROVED PROCESS AND APPARATUS FOR DISTILLING TAR AND OTHER LIQUIDS, William Glossop, of Highfield, Hipperholme, near Halifax; Luke Bradley, of Thornhill House, also of Hipperholme; and Ralph William Willsdon, of Copmanthorpe, York.

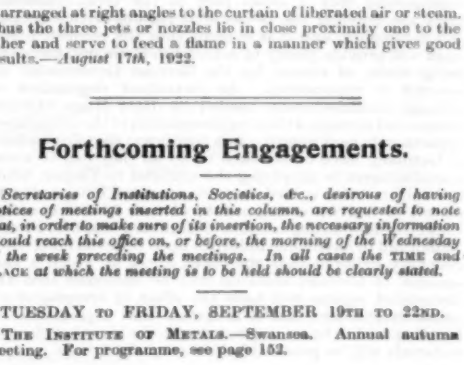
The object of this invention is to provide a safe method of distilling tar and other liquids containing water. The apparatus comprises a series of superimposed plates arranged to provide a zigzag path for the tar by one plate being inclined to deliver the tar to the top of another plate, which is inclined in the reverse direction, and delivers on to the top of a third plate and so on



throughout the series. The outlet from the still is placed near the bottom so that there is never a large body of tar at the bottom of the still. Means are provided for maintaining the flow of tar into the still, so that at all times only a thin film will be present upon the plates. The still may be heated from the bottom or at the sides, or both, and the rising vapours assist the process of distillation. The tar may be preheated before admission to the still. It will be observed that with apparatus of this kind a continuous process of distillation can be carried out, and the tar from one still can be passed on to another operating at a different temperature.—*August 2nd*, 1922.

184,285. May 17th, 1921.—IMPROVED BURNER OR ATOMISER FOR LIQUID FUEL, Samuel McIntyre Saunders, of Saunders and Taylor, Limited, of 43, Lower Moseley-street, Manchester.

According to this invention a disc, film, surface or curtain of air or steam is produced by the liberation of air or steam from two opposing jets or nozzles preferably located at right angles to one another, whilst the jet or nozzle delivering the liquid fuel



is arranged at right angles to the curtain of liberated air or steam. Thus the three jets or nozzles lie in close proximity one to the other and serve to feed a flame in a manner which gives good results.—*August 17th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TUESDAY TO FRIDAY, SEPTEMBER 19TH TO 22ND.

THE INSTITUTE OF METALS.—Swansea. Annual autumn meeting. For programme, see page 152.

TUESDAY, SEPTEMBER 26TH.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, E. 1. Film illustrating industrial works, Messrs. Vickers. Ladies' night. 6.30 p.m.

WEDNESDAY, SEPTEMBER 27TH.

INSTITUTE OF COST AND WORKS ACCOUNTANTS.—The Institute of Chartered Patent Agents, Staple Inn Buildings, W.C. 1. Inaugural meeting. "Collection of Data for Ascertaining Overhead Expenses," by Mr. R. Stelling. 7 p.m.

THURSDAY, SEPTEMBER 28TH.

INSTITUTION OF BRITISH FOUNDRYMEN.—The Institute of Marine Engineers, 85/88, The Minories, Tower Hill, E. 1. Presidential address by Mr. Wesley Lambert, M. Inst. C.E. 7.30 p.m.

FRIDAY, SEPTEMBER 29TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Metropolitan District meeting at Poplar and Port of London Authority's Docks. 11 a.m.

MONDAY, OCTOBER 2ND.

BRADFORD ENGINEERING SOCIETY.—The Technical College, Bradford. Presidential address, "The Development of Public Electricity Supply," by Mr. C. E. Allsopp. 7.30 p.m.

FRIDAY, OCTOBER 6TH.

INSTITUTE OF COST AND WORKS ACCOUNTANTS.—Connaught Hall, Newcastle. For the purpose of inaugurating a branch in the Newcastle district. Paper, "The Necessity for Scientific Costing," by Mr. S. Hunter. Tickets may be obtained from the secretary at 38, Grosvenor-gardens, S.W. 1. 7.30 p.m.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. First meeting of winter session. Paper, "Engineering in Bacon Factories," by Mr. W. A. Tookey, M.I. Mech. E. 7.30 p.m.

SATURDAY, OCTOBER 7TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Guildhall, Grantham. East Midland District meeting. 10 a.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Doncaster. North-Eastern District quarterly meeting. 2 p.m.

TUESDAY, OCTOBER 10TH.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, Tower Hill, E. 1. "Conditions to Get High Economy from Oil Fuel," by Mr. A. Keenes. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MICHAEL H. P. ALLEN, A.M.I. Mech. E., has resigned his connection with Burton, Griffiths and Co., Limited, to take over the sole representation of Bell's United Asbestos Company, Limited, in the Leeds and North Lancashire district.

THE IRONCLAD SWITCHGEAR COMPANY, Limited, asks us to state that its new London address is 23, Queen Anne's-gate, Westminster, S.W. 1. The London office will deal with inquiries and orders emanating from South Wales, the Midlands, East Coast, southern counties and overseas.

D. ANDERSON AND SON, Limited, of Manchester, London and Belfast, makers of the "Belfast" roofs, roofing felts and "Sidol" wood preservative, have established their administrative headquarters at Park-road Works, Stretford, Manchester, to which address all correspondence should be sent.

MR. ERNEST WILSON informs us that he is now associated with Spear and Jackson, Limited, of Sheffield, on their sales staff in London. Mr. Wilson was for eleven years with Sir W. G. Armstrong, Whitworth and Co., Manchester and London, and has just returned from an extended business trip abroad.

WE are informed by Alfred Herbert, Limited, that agreements have been signed between the Cleveland Automatic Machine Company, of Cleveland, Ohio, U.S.A., and themselves, whereby they become the authorised sole selling agents for the Cleveland automatic screw and forming machines. The services of Mr. H. Asbridge, who has been the Cleveland expert in this country for many years, have been retained by Alfred Herbert, Limited.